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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Birmingham Convention.

It is obvious from a study of the detailed programme of the forthcoming convention of the Institute of British Foundrymen that the outstanding feature is the automobile foundry. The President-Elect, Mr. Andrew Harley, is connected with this industry, and he has the honour of being the first chairman chosen from its ranks. In the past, the large jobbing, pipe, non-ferrous and heavy engineering foundries have supplied the bulk of the Presidents, yet there is no branch of the industry which is more go-ahead or has contributed more to the science of the rapid production of precision castings than the automobile industry. Truly, viewed from this angle, Mr. Harley's election is somewhat belated.

The works visits arranged for include a number of the most prominent automobile foundries and from close personal contact with this industry we would stress that more of their methods are applicable to founding generally than would be expected from a cursory examination. But the most important feature is that its personnel is better documented than in any other section; by this we mean that less empiricism exists, and any inquiry as to methods, composition, cost and performance is immediately answered in plain English by the executives of the industry. This constitutes the best reason why every available foundry executive should take advantage of the hospitality extended by the Birmingham and district section.

The Papers to be presented include two of a novel character. It is recognised that—not by intrinsic merit but by better selling methods—certain industries are poaching on the preserves of the foundry. Thus the Institute has made two advances. One is to ask the engineer just what he expects from the foundry, and, secondly, to secure information as to the latest and best methods of marketing foundry products.

The social side has been more than adequately provided for, as reference to the detailed programme will show. These functions certainly provide an incomparable channel for the informal exchange of views on technical matters. Experts from every section of the industry are always present, and are only too ready to give the benefit of their advice to their less experienced *confrères*. Birmingham is a particularly convenient centre, and the programme is such that no excuse, other than ill-health, can be tenable. Whilst it may not be a record meeting, the arrangements made certainly warrant such a consummation.

Patent Law Reform.—II.

It is well known that a patentee may threaten with legal proceedings one who is supposed to be infringing his patent, and the party threatened has no remedy if the action is "prosecuted with due diligence." Now this leads to a very unsatisfactory state of affairs, because the phrase is very elastic, and may cover a period of months, during which a man who has no intention of going to law may do serious damage to a perfectly legitimate business. An action commenced may be abandoned as soon as a defence is entered. Where a process is in question, the action lies against the user, who generally is in no way anxious to be made a party to legal proceedings, so he refrains from buying from the threatened manufacturer.

The Patent report referred to in our columns recommends that the law be amended so that the person aggrieved may himself bring an action and obtain an injunction against the continuance of the threats, and may recover any damage he has suffered as a consequence. It is provided that the owner of the patent may counterclaim for infringement. Thus the threatened party will be placed in a position to compel the threatener to implement his threat at once; in other words, threats which are merely intended to intimidate for a period long enough to keep others off the market will disappear, while those who really have just cause for complaint will not suffer.

We come now to some of the suggestions which the Committee does not adopt. Invention is usually described as any manner of new manufacture. There is a strong feeling that scientific discoveries should be patentable in the same way. The report does not recommend any alteration to existing practice or the broadening of the interpretation of the word "invention." Again, the cost of patent litigation is responsible for the suggestion that the Comptroller of the Patent Office should have power to decide certain patent disputes if requested by the parties concerned. Often a man would like to know whether he is, in fact, infringing a patent, and the patent owner would like to know if it is being infringed. At present they only have recourse to the costly and tedious processes of law. A minority of the Committee was in favour of this change, but no recommendation to this effect is made. The Committee, dealing with the fear that inventions arising from scientific research might be prejudiced by that reason, considers that the Courts would be benevolent rather than otherwise to inventions originating from organised scientific research.

An important proposal to establish "short-term patents" for useful designs on the lines of the German model was negatived, after a good deal of consideration. This, also, was very widely supported, because the margin of patentability of many patents is small, and something less than a patent for a shorter term at a smaller fee and granted without delay would meet a public need. A new design of a minor constructional detail on a cupola would be a case in point.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Soda Ash in the Foundry.

To the Editor of The Foundry Trade Journal.

Sir,—Many foundrymen will be specially interested in the note in your issue of April 30 on "The Desulphurising and Refining of Grey Cast Iron with Soda Ash," by such able metallurgists as Messrs. Colbeck and Evans.

The writer has had considerable experience in the use of soda ash as a desulphuriser of cast iron, and in many successful attempts to reduce the sulphur content in cast iron for wrought-iron manufacture, where an exceptionally low sulphur content is desirable, Brunner Mond soda ash has been used, the amount added being about 1.5 per cent. of the metal treated.

In a recent test made in the foundry at the Netherton Iron Works, soda ash in about the above proportion was added to the ladles, the metal being used for the casting of small cylinders chilled on the outside.

The rising heads of these castings made with and without soda-ash additions were analysed, the "heads" of the treated castings showing a very considerable increase in the sulphur content, so much so as to convert the otherwise grey fractured metal into white iron in the heads, and at the same time lowering the sulphur content in the cylinder portion of the castings, the sulphur being lowered by about 0.08 per cent.

Some difficulty had been experienced due to the pocketing of the liquid soda silicate slag in the upper portions of the castings until additions of limestone or purple ore had been made to the slag rising to the surface of the ladles, thus enabling a thicker slag to be formed which could be readily skimmed off the metal before casting.

Soda ash in the form of compressed cakes or tablets is commonly used in the U.S.A. for desulphurising purposes, and the writer saw such cakes being very effectively used when tapping the cupolas employed for supplying molten cast iron to the Bessemer converters used in the manufacture of very pure ingot iron.

As the authors state, it is essential that the cupola iron should be tapped at high temperatures, but, if such iron is highly oxidised in the cupola during melting, the degree of desulphurisation is affected.

The results shown in Tables III, IV and V indicate that abnormal silicon losses occurred, the average losses being as shown below in the case of the soda-ash-treated metal.

Table III.—The mean silicon content of the four treated irons being as charged 2.0 per cent. and in the castings 1.58 per cent., a silicon loss of 0.42 per cent.; whereas the manganese content as charged averaged 0.38 per cent. and in the treated castings 0.25 per cent., a loss of 0.13 per cent. In this series, soda-ash-treated iron lost approximately 72 per cent. of the sulphur originally present in the metal as charged.

Similarly in *Table IV* the mean silicon content of the four irons was 1.92 per cent. before melting and 1.55 per cent. after melting, a loss of 0.37 per cent.

The mean manganese content before melting was 0.375 per cent. and after melting 0.18, a loss of 0.195 per cent. Here, the sulphur content in the treated castings was 52 per cent. of the amount in the metal as charged.

Further, in *Table V*, the silicon loss during melting was 0.42 per cent. and the manganese loss 0.255 per cent. The sulphur contained in the treated metal was 53 per cent. of that present in the charged metal.

The writer has not noticed hitherto the apparent effect of hot oxidised metal on the soda-ash action in desulphurising the metal, but it would appear likely that the desulphurising effect is encouraged under such conditions, and it may well be that the refining effect on the graphite size alluded to by the authors is connected with a kind of scavenging action promoted by the main chemical action as described by the writers, whereby the sulphide of soda formed and the CO_2 liberated assist the occluded gases and iron-oxide inclusions to rise and escape through the feeder heads.

This explanation, of course, suggests that the whole of the reactions may not finish in the ladle but continue in the mould where, obviously, the refining of the graphite before or during solidification must take place. The photomicrographs, Figs. 2 and 4, are interesting in this connection, and definitely show that the soda-ash additions have probably helped in liberating included gases as well as in the action of desulphurisation.

It would be rather disconcerting, however, if one had to conclude that desulphurisation is effected readily only in metal which has been seriously oxidised during melting.

It is of course, already well known that refining of the graphite flakes is best secured when the metal temperatures are in excess of, say, 1,400 deg. C., but the writer does not remember any suggestion having been made hitherto that escaping gases and oxides, which would produce agitation in the molten metal, may play an equally or more important part.

It is known that the higher the temperature of the molten metal the more gases and iron oxide can be held in solution or suspension. Any internal agitation, such as may be produced by the addition of gas-forming substances, such as soda ash, may conceivably help to bring about the refining of such graphite as is in suspension in the fluid metal during the time interval between the beginning and close of the period of gas escape—from the boiling stage to that of tranquility. It is further obvious that the soda-ash reactions will complete themselves more perfectly when the amount of metal superheat is greatest, in which case the duration of the gas-release period will be lengthened.

Finally, the writer, whilst agreeing that effective desulphurisation of cast iron is desirable, hopes that foundrymen will not be tempted to use high-sulphur coke or abnormally high percentages of impure cast-iron scrap. If the authors could continue their experiments with cast irons made from charges rich in steel scrap, which are great sulphur absorbers during the melting process, further valuable data would be available for the foundryman's use.—Yours, etc.,

J. E. Fletcher.

11, St. James' Road,
Dudley.

May 1, 1931.

German Iron Foundry Owners' Federation.

The year 1931 began with a great change in the Board of Directors of the above Federation. Dr. Werner, who for 18 years had acted as its President, found himself obliged towards the end of 1930 to carry out his intention of resigning from the office of President. The Vice-President, Baron von Wittgenstein, in the interim took over the presidency. A meeting was called by the Council in Berlin, towards the middle of January, in order to make the choice of a new President. At this meeting, Mr. Schulz, who had had the intention of resigning from the Directorate for many years on account of health reasons, definitely decided to do so. After considerable discussion of the general position, Baron von Wittgenstein was elected President and Dr. Brehm, Berlin, Vice-President. In the place of the two gentlemen who had resigned Dr. Ing. Humperdinck, of Wetzlar, and Mr. Schönbrodt, of Leipzig, were elected. The Board of Directors now consists of the four gentlemen already mentioned above and Dr. Waldschmidt, of Berlin, and Chief Mining Director Meinel, of München.

Random Shots.

Unaccompanied by a certain gallant little Welshman, and unencumbered by the shovel and the hoe, we are fast getting back to the land. The expression "hiker"—thanks to the popular Press—has lost its novelty. The demand for rucksacks increases by leaps and bounds. Staffs are torn from the iron limbs of trees. The countryside is invaded by roving bands and strong and terrible hikers grapple with Nature at close quarters. "Marksman" leans back upon the cushions of his punt, silences the gramophone and applauds this open-necked, bare-kneed display of vitality. Under the influence of Dr. Snowden's infallible 75:25 mixture he may himself shortly take to the open road. . . . .

* * *

Attendant upon this hiking vogue is the youth-hostel movement, which aims at providing accommodation for the modest charge of a shilling a night. The mushroom rapidity with which these hostels are springing up probably has caused our Rip Van Winkle innkeepers to rub their eyes and marvel. It may even induce them to repaint their signs, smarten up their service and lower their charges. At present wayside inns have picturesque tradition and little else in their favour. But with the aid of a Chesterton-minded publicity expert they might once more capture the fancy and patronage of road travellers.

* * *

Rejected by the Royal Academy.

Before an art-dealer's window.

'Arry to 'Arriet: "These ere scratching pikchures are all the rage."

'Arriet to 'Arry: "Yes, 'itchings' they calls 'em."

"A sale of Rembrandts? But my dear, how *shattering*! I thought you said a sale of *remnants!*"

* * *

Devotees of the talkies should have no difficulty in visualising a setting for these two monologues. Their connection is obvious:—

(1) "Hello—Canal seven-two-eight-three—hello—hello—that you Tony? Jack speaking—say, Tony, cop saw me taking th' stuff outa the' car—yeah, yeah—says he wants to see me, the big sap—yeah—better slip him twenny-five bucks—*twenny*-five, I said—yeah, I'll watch it—Okay, Tony."

(2) "Wal, Cap'n—here y'are, I spoke the boss—he says make it three bucks, but I talked him up to five—yeah—oh, *that's* all right, Cap'n, we all gotta live—Don' I know it—ha, ha!"

* * *

Imaginary Intimate Interviews.

IV.—*The Foundry-Equipment Agent.*

Bithneth ith not goot, Isaac. To mine client in Aberdeen I say, "Monsieur McDuff, wish you to purchase installations complete and modern for the preparation of sands for moulding?" And he say, "Nay, mon." I say, "Wish you moulding machines to buy, Herr McDuff?" And he say, "Nay, mon." I say, "Wal, McDuff, d'y' wan' a few sooper conveyors to peg up production?" And vot you tink he say? He no say "O.K. by me, chief." He no say "Yeah, brother." He just say "Nay, mon." Bithneth ith not goot. Bithneth ith not at all goot!

Marksman.

Foundry Selling Practice.

By Eric N. Simons.

(*Continued from page 280.*)

No. 3. SCIENTIFIC STUDY OF MARKETS.

The modern foundry has paid insufficient attention to the scientific study of its markets. Too often the principle has been to make certain types of castings, generally after noticing that other people were doing well out of their manufacture, and then to proceed to sell them. If the market happened to be unsaturated, this policy paid. If it was saturated, another promising business went into the Receiver's hands. The notion that it was possible to formulate beforehand a fairly comprehensive and accurate indication of the extent of the market was not entertained.

Now the scientific analysis of markets is not necessarily confined in its advantages to the business about to begin. It is as valuable and important to old-established businesses. The purpose of this series of sections on market study is intended to clear away misconceptions and to indicate hitherto unexplored possibilities.

First of all, what is the market for a foundry product? It is not a fixed and certain quantity, and in that sense investigation of it can never be wholly scientific. A market is the total number of possible users or purchasers of the product existing in the world at a given moment or period. Markets are human and existent, therefore they are measurable but fluctuating. They are governed by the ordinary economic laws, and if only the founder had all the data in his possession, he would be able to forecast as accurately as necessary for his purposes the reactions and behaviour of the market in relation to his product, and its capacity to absorb his output. But no man can possess all the given data without proper inquiry and research. If market judgment in a manufacturer is unsound, it is much more likely to be because he is ignorant of the facts than because of some ineradicable waywardness in the market itself. Forty years ago, production was as haphazard and unplanned as marketing is to-day. There is reason to believe that in the future victory will go to the founders who first decide to put their selling upon as scientific and organised a basis as their production.

Market Investigation.

The first step in this direction is well-planned market investigation. One may rightly inquire at this point: what is meant by market investigation? What, exactly, does it imply? How is it carried out? Of what benefit is it to the business?

Market investigation is, briefly, a study of the character, scope, and special peculiarities of the market, carried out on scientific principles and by organised, systematic methods, with particular reference to the best way of supplying the product to the market. And the first step in market investigation is to find out the facts, not opinions, not theories, not pet notions and "I reckons," but actual, hard facts, capable of being charted, plotted, mapped, and calculated. Market investigation implies, therefore, the expenditure of time and money on the collecting of these facts.

The advantages to be derived from this work are as follows: (A) Market investigation teaches one the number, buying power, buying principles, habits and prejudices, of the actual consumers of the goods, thereby improving the understanding of the market; (B) it reveals markets hitherto unexploited, indicates the position of these markets, and defines their potentialities and limitations; (C) it indicates, in addition, the markets for subsidiary products of the foundry, or by-products of the process; (D) it enables a proper selling scheme to be drawn up, based on actual market requirements, not on mere guesswork; (E) it presents the advertising department with fresh points of view and proper selling arguments based on the consumer's needs; (F) quite often it indicates where changes in the design or composition of the castings would increase trade or enable other markets to be attacked; (G) through its indication of the maximum extent of sales, it enables purchasing to be carried out more scientifically, with consequent minimisation of overbuying or under-buying, and (H) it reveals any weaknesses in the distributing methods, and suggests how they may be improved.

Preliminary Considerations.

This is a formidable list of advantages, but it must be interpreted, of course, as a list of potential advantages primarily. Now the founder deciding upon a comprehensive inquiry into his markets must, before he rashly embarks upon any wild-cat scheme, sit down and give serious thought to the whole problem.

He must decide in his own mind before he goes a step farther, the following points: (1) Is he prepared to give his sales staff every opportunity to carry out their investigations thoroughly? (2) is he clear in his own mind what results he can expect, and whether they warrant his spending the money? (3) has he convinced not only his sales staff but his colleagues and any section of the foundry that may have to collaborate with the investigators that the scheme is sound? Is he sure they all understand what he is proposing to do? (4) is he clear that the investigation must be properly planned in advance, not merely rushed into haphazard? (5) has he decided who is to do the work? and (6) is he prepared to make use of the facts revealed by the investigation, or is he going to pigeon-hole the report when it is in his hands?

Having answered satisfactorily these questions, and having made up his mind to analyse his market, the founder may then begin to think of how it is to be done. And here one must answer in advance an objection frequently brought against any such close and careful investigation. "This market report business," the objectors say, "is the salesmen's job. They send in their daily or weekly reports, and that constitutes as much market investigation as my business needs. I know my men outside, and can trust their judgment. What need is there for anything more? If I want a bit of special information, I can always drop them a line and get it from them."

The answer to that argument is, bluntly, that it is fallacious. The shrewd report made by the experienced salesman is largely founded upon a kind of intuition, born of long association with the market in his district. It may be accurate in essence. It often is. But it is not scientific. Not infrequently it is wrong. The thorough market investigation discounts intuition and relies on ascertainable, demonstrable facts, which can be checked and counter-checked to any extent desired. The difference is one of accuracy. For instance, one foundry formed the impression that it was not getting as much of the business in a particular territory as it thought it should. It consulted the salesman as to the advisability of taking special distributive and selling measures to increase the turnover from that territory. The salesman declared it was unnecessary to do so. The market in the territory was saturated. There was, in short, nothing to be done. The foundry was not convinced, and sent out a special investigator, who, by facts and accurate reports, indicated that the market was almost double what the salesman considered it to be. The suggestions he made were acted upon, and the result was that this particular territory is now one of the most lucrative of all those covered.

It must be stressed that a market investigation is useless unless it tells the truth, however unpalatable. If the foundry is not prepared to listen to the truth about its selling organisation or methods, then it does not need a market investigation.

(*To be continued.*)

Lancashire Junior Foundrymen.

The annual meeting of the Lancashire Junior Section of the Institute of British Foundrymen was held on April 25 at the Manchester College of Technology, Mr. H. V. Grundy presiding. The balance sheet was passed on the motion of Mr. Simpson, seconded by Mr. Gilpin, and showed a credit balance of £7 7s. 5d. at the end of the year.

Mr. R. W. Stubbs said the fact that this Junior Section had held its own, whilst certain other Junior Sections had gone out of existence, was proof of the excellent way in which it had been conducted.

A vote of thanks to the retiring officers was proposed by Mr. Gilpin, seconded by Mr. G. Platt, and carried unanimously. In acknowledging it, the President thanked the joint hon. secretaries and the Council for the help they had given him and their services to the Section. The election of officers resulted as follows:—President, Mr. H. V. Grundy; Vice-President, Mr. R. A. Jones; treasurer, Mr. R. Yeoman; secretary, Mr. A. Burgess; council, Messrs. E. Sutcliffe, B. Haigh, G. Platt, B. Simpson, A. Flower, D. Menzies, F. Greaves.

Mr. W. Jolley congratulated the members on the progress they were making, and praised the way in which their socials were conducted.

Mr. J. S. G. Primrose announced the results of the John Wilkinson Medal examination:—First, J. Holmes; second, E. Sutcliffe; third, B. Haigh; and highly commended, Messrs. Menzies, Thompson and Brandret. A vote of thanks to Mr. Primrose for his long and excellent services in connection with this examination was passed unanimously.

Publication Received.

Proceedings of the South Wales Institute of Engineers, Vol. XLVII, No. 2. Published by the Institute, Park Place, Cardiff. Price 5s.

Never has the "Proceedings" of any engineering or metallurgical society, except those specifically catering for the foundry industry, contained so much of interest to our readers. It records the final phases of the discussion on Mr. J. Selwyn Caswell's Paper on "Sheet and Tinplate Rolls." An investigation into the roll loads, stresses and the causes of roll breakages, and "Fatigue Stresses with Special Reference to the Breakage of Rolls," by Prof. Frederic Bacon, together with an extended discussion by experts from all over the world. Amongst people prominent in the foundry industry who have contributed to the discussion are Mr. John Shaw, Doctors Jungbluth and Mailänder (of Krupp Research Laboratory), who presented data to show that the coefficient of thermal expansion of white iron is not twice that of grey, as is popularly believed; Mr. J. G. Pearce (who gave reasons, based on Mn and sulphur ratio, for the addition of manganese to roll metal, diminishing the chill); Mr. R. B. Perry, Mr. A. Allison, Prof. Desch, Dr. R. H. Greaves, Dr. W. H. Hatfield, Mr. R. B. MacGregor, Dr. F. Rogers (who claimed to have located the incidence of incipient cracks in the structurally-free cementite of the chill) and Dr. Gough, of the National Physical Laboratory. The one unsatisfactory feature of the whole subject is a lack of definition of exactly what is meant by fatigue, and it is interesting to note that the North-East Coast Institution of Engineers and Shipbuilders have set up a committee to consider and report on a suitable definition for this word. The foundry industry is, indeed, appreciative of the sterling work done by Prof. Bacon and of Mr. Caswell.

When lapping ordinary steel use kerosene as a vehicle; for the tungsten or carbide steel use olive oil.

The Scrap Situation.

By "Onlooker."

Up to a short time ago the market prices of scrap metals, although low in comparison with those ruling twelve months or even six months earlier, were yet relatively dear when compared with their value in terms of virgin copper and spelter. Two or three reasons may be given for this, one of which is the fact that consumers were more inclined to consider scrap in place of new copper, a preference which has somewhat waned since the value of the red metal has declined to about £40 per ton. Spelter, too, is markedly cheaper, and at £10 10s. per ton for this metal old brass must be offered at a very reasonable figure if consumers are to be tempted in preference to a purchase of zinc. Latterly, too, there has been an inclination on the part of dealers and others holding scrap to turn metal into money, in sheer despair that markets were ever going to mend their ways, and the scrap thus made available has tended to depress the margin between old metals and new.

As already mentioned, the demand for scrap has fallen off, but it seems likely, too, that as far as this country is concerned, rather more old metal is coming on to the market. This, if it be a fact, is a healthy sign, for it means that consumption of new metals has taken a turn for the better; and, moreover, that there is more inclination to "scrap and replace" than has been the case for some months past. The supply of American scrap must be regarded from rather a different angle, however, and in spite of the serious decline in trade activity over there, old metal has all along been available, provided that the buyer were prepared to pay the price asked. At the present moment the situation in the States seems to be summed up in the fact that when the new metal markets are depressed holders will not let go at current values, whereas when a rise comes buyers are not easily to be persuaded to make purchases. Rather an extraordinary state of affairs, but entirely typical of the difficult days through which the metal trade is at present passing!

The scrap metal trade is not one for which statistics are easily available, although estimated figures are usually published annually by the American Bureau of Metal Statistics. Certainly in the world of old metals we do not get that "statistical paralysis" so noticeable in the four chief non-ferrous metals to-day, and buyers and sellers are, therefore, left to a great extent to make up their own minds without undue persuasion from Press comments or statisticians. In this country the scrap metal business is to a great extent local, and areas such as London, Birmingham and Glasgow have their own particular specialities and prices. Of late years there has been a tendency for districts to merge, and no doubt road transport has had a good deal to do with this. At any rate, values ruling in this country are to a great extent separate and distinct from Continental quotations, although there is, of course, an interchange of parcels between Britain and Germany, France, Holland and Belgium, while on occasions we have seen quite a steady drain from this country to abroad.

In spite of quiet times in the shipbuilding trade and rigid economies by our railway companies, a fair amount of old metal is coming from the shipbreakers and the departments which deal with the "condemned stores" of the railroads. This flow of scrap is, of course, well below normal, and quite unable to cope with anything approaching the demand in existence a couple of years ago. In fact, it seems highly probable that the reserves of old metal built up during the period of trade activity are practically exhausted, and that we have now reached a stage of dependence upon scrap released by current conditions, which is certainly not a big tonnage. For the present, with demand depressed, this state of affairs does not matter, but sooner or later we are going to see a revival of business, and that is when the shoe will pinch. The "between period," and more particularly if there should prove to be a fairly sharp revival of activity in the brass and copper mills, will bring a demand for old metals which it will tax existing reserves to meet, and it is then that we may very easily see the margin between scrap and virgin metals definitely narrowed.

With brass scrap selling as to many grades below £30 per ton there can be very little profit for the itinerant collector of old metal, and it is not surprising to learn that in the States the "junk merchant," as he is usually termed, is turning his attention to anything rather than non-ferrous metals. In two words, scrap, like the virgin metal, is on the border line of production cost (this, of course, does not refer to process scrap), and it is fairly safe to assume that if copper and spelter are good lock-up purchases, old metals are equally favourable.

Birmingham Foundrymen's Annual Meeting.

The annual meeting of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen was held on April 23, the Branch-President (Mr. D. Wilkinson) in the chair. The hon. secretary (Mr. F. K. Neath) read his annual report, which showed that the Branch membership stood at 230, and that 33 new members had been elected during the session. He referred to the Institute's forthcoming Annual Conference in Birmingham, and appealed to all members of the Branch to support the various functions which had been arranged. The accounts showed a record in the subscription income and a credit balance of over £60. The chairman moved the election of Mr. F. J. Hemming as Branch-President for the ensuing session, and this was carried unanimously. Mr. Hemming then took the chair and the following elections were made. Senior Vice-President, Mr. J. G. Pearce, M.Sc.; Junior Vice-President, Mr. E. J. Lewis; hon. secretary and treasurer, Mr. F. K. Neath, B.Sc.; assistant hon. secretary, Mr. L. W. Bolton; Branch council, Messrs. H. J. Roe, G. M. Callaghan, W. H. Moore and E. N. Wright; representatives on the General Council, Messrs. J. B. Johnson, H. J. Roe, W. J. Flavell and E. H. Tyson. The business meeting terminated with a vote of thanks to the officers and council, proposed by Mr. F. J. Cook.

Gating and Pouring of Castings.

Following the business meeting, a lecture was given by Mr. E. Ronceray, the well-known French foundry-equipment manufacturer, on "Gating and Pouring." Before giving his lecture, Mr. Ronceray extended a warm invitation to members of the Branch to attend the International Conference in Paris in 1932.

He then dealt with the requirements necessary for the production of castings, emphasising the considerations of soundness and price. The influence of such factors as uniform mass cooling, cooling by parallel layers, and feeding during solidification was explained, and examples of methods of running and gating various castings, and of feeding them to produce soundness, were given. The "Leonard effect" was dealt with, and also the use of filter cores. A number of illustrations were shown on the screen by means of a small projector using a strip of film instead of the usual lantern slides.

DISCUSSION.

The Chairman welcomed Mr. F. M. Gaussen, of Australia, who was present, and Mr. Fassotte, a Belgian steel founder.

Mr. J. G. Pearce, in proposing a vote of thanks, referred to Mr. Ronceray's work in connection with the French Foundry High School, and also complimented him on his skill as a lecturer in the English tongue. With regard to the "Leonard effect," he thought that in this country this would be more appropriately termed the "Fletcher effect." He would like to ask the lecturer if he did not think that the ideal method was melting at the highest possible temperature and subsequently pouring at the lowest practical temperature. He agreed with the point that sound castings were to be aimed at.

Mr. E. N. Wright, in seconding the vote of thanks, expressed his appreciation of the many practical points which the lecturer had put forward.

Mr. Fassotte stated that he had never heard so much practical information in the course of an hour. He had found that in making steel castings the filter-core method gave extraordinary efficiency and saving in cost. He gave an illustration of a casting in which the use of a filter core had resulted in a slight profit being made on a previously unprofitable casting. He agreed with the lecturer on the question of speed of pouring. In making buffer cases, he had found that slow pouring with pencil runners gave sound castings, due to the subsequent parallel layer cooling.

Mr. F. M. Gaussen thanked the lecturer for his helpful address and also agreed with the remarks of Mr. Fassotte. With regard to the mould pouring, he thought that a definite positive pressure should be maintained in the mould during pouring, and this could be done by arranging for suitable venting. He had found in casting flat plates that if the vent wire were pushed through to the pattern and then the holes were closed up at the mould face, better results were obtained than if the vent holes were left open.

The Chairman said that he would like to ask Mr. Ronceray if he would recommend filter cores for general use with steel castings. The abnormal shrinkage would demand a lot of practice and careful control of metal temperatures.

Mr. Ronceray replied that he had no experience of steel castings. He had always thought it necessary to bottom-pour steel castings, but Mr. Fassotte had shown this was not essential. If Mr. Fassotte produced 200 buffer cases a day from converter metal, there should not be any difficulty regarding control.

Mr. A. J. Shore asked if pencil runners required higher temperatures of pouring, to which Mr. Ronceray replied that large castings could be poured by this method without the necessity of holding the metal before pouring, as with ordinary runners.

Mr. Wilkinson emphasised that it was not possible to dogmatise on methods of making steel castings, as each casting had to be given individual consideration. He gave an illustration of a gun-mounting base, weighing 12¼ cwts. and 4 ft. 6 in. high, which he had run at the bottom with a ¾-in. dia. runner and tangential gate, the runner only weighing 15 lbs.

Mr. Cook referred to oxidation cavities which were not controlled by gating and pouring methods. He also mentioned the syphon-brick methods for tapping the cupola, which he thought had not received the consideration in this country which it deserved. With regard to the filter core, he had used this method 30 years ago.

Institute of Industrial Psychology.—The annual report of the National Institute of Industrial Psychology records that in every one of the many fields of the Institute's activities 1930 has proved another record year. Membership of the Institute has increased from 1,430 to 1,600. The number of applicants for vocational guidance has increased by more than 50 per cent. compared with 1929. Investigations in factories, etc., have covered a varied field, and it is pointed out that in a review of the past ten years the most satisfactory feature has been that not only have investigations been carried on for periods varying from one to eight years, but firms have come back to the Institute for further help.

The Use of Refined Metals in the Foundry.*

By D. R. Tullis.

The object of this Paper is to explain as clearly as possible the exact difference between a refined and an unrefined metal, to point out the advantage of using refined metals in the foundry. The processes described can be applied to a large number of alloys including aluminium, lead, copper and the tin-base alloys. These processes have mainly been applied to aluminium and its alloys because the difficulties to be overcome with aluminium alloys are not so great as has been found with copper and other alloys. The process known as the chlorine-refining process has created widespread interest among users of metals and alloys which are known to possess certain inherent difficulties caused by the presence of dissolved gases and the capacity of producing coarse-grained weak castings.

Chlorine Refining Process.

The difficulties of applying the process to the refinement of copper, tin and lead alloys is mainly due to the fact that the resulting volatile chloride fumes are very poisonous. Other difficulties are due to the employment of suitable refractories capable of conveying the gas into the molten metal. The only suitable refractory at present in use is fused silica. Copper-rich alloys in the molten state rapidly destroy silica tubing. Application of the process has therefore mainly been confined to aluminium and its alloys. Metals of this type are very prone to contain quantities of dissolved gases and other impurities such as carbide, nitride and oxide of aluminium. The presence of these impurities is the cause of practically all the troubles and defects in aluminium castings.

Dissolved gases and oxide of aluminium are the cause of all soundness except contraction unsoundness in aluminium alloys. The presence of carbide and nitride of aluminium causes increased hot-shortness, poor fluidity, low ductility and increased corrosion in cast aluminium alloys. One of the main objects of the process is to remove these impurities and thus produce a metal of greater purity. Certain alloys of aluminium are liable to produce weak coarse-grained castings accompanied by cracks and marked hot-shortness. A further development of the process removes these defects.

In carrying out this refining process, no special type of plant is required in the initial melting operation. Various types of furnaces may be used and the risk of gas contamination during melting is of little account. The actual refining process may be carried out in a number of ways but in all cases, special plant is required. Great care is necessary in the selection of suitable refractories and means of collecting and condensing the resulting dense white fumes which are evolved. The molten metal is transferred to the refining vessel and a rapid stream of chlorine or chlorine gas compounds is passed through it. A very rapid stirring action takes place which is accompanied by a rise of temperature.

How Chlorine Affects Molten Al.

During the earlier stages of treatment, the dissolved gases are expelled and may be seen burning on the surface of the molten metal. Almost immediately a grey dross begins to collect on the surface near the point where excess chlorine escapes. In a few minutes, it can be seen that the metal is much more fluid. During the process, small dip samples are removed and poured into a refractory mould. As the sample cools, it is carefully examined in order to see if any dissolved gas is evolved during freezing. When the process is nearly completed, the temperature of the metal begins to fall. The surface dross is now quite white in colour and consists entirely of alumina which has been deposited by the decomposition of the aluminium chloride. The aluminium chloride vapour formed during the reaction produces great heat and acts as a powerful scavenger as it rapidly ascends through the molten metal. Suspended alumina in the molten metal is removed and collects on the surface. Two distinct forms of alumina can be noted. One is grey in colour and the other is pure white. The aluminium chloride vapour which is condensed at about 300 deg. C. is removed and collected in suitable tanks. It forms a valuable by-product and is used in the chemical industries. The refined metal is now ready to cast into ingots.

The appearance of the refined metal is quite different from that of the original metal and can best be seen by an examination of samples.

The Problem of Grain Size.

Fig. 1 is an example of ingots cast during the refining process using chlorine gas. In many cases the refined metal is so different in appearance from the unrefined metal that it is difficult to believe that it has come from the same heat of metal. During treatment with pure chlorine gas, the grain size of the metal samples increases considerably and the metal approaches more nearly to the large grain-throwing capacity found in all pure metals. The effect is caused by the removal of certain impurities which are known to possess a nuclear-forming capacity with the result that the crystals have fewer starting points for crystallisation to commence at. This also causes more rapid growth to take place.

A metal of this type possesses certain obvious disadvantages from the foundry point of view, although it may be improved in other respects.

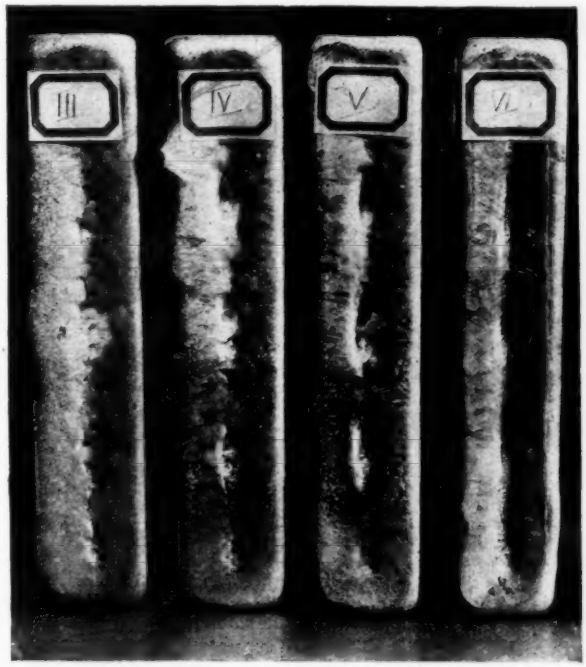

Fig. 1.—Surface of Ingots Degassed.

For this reason the second step in the refining process has been developed. It has for its object the introduction, in the correct state, of certain elements which are known to possess a high nuclear formation. In this way the disadvantages of the plain chlorine treatment are eliminated. A more extensive application of the process has a close bearing on the mechanism of modification and opens up a wide scope for investigation of interest to the technical metallurgist.* It forms an introduction to the

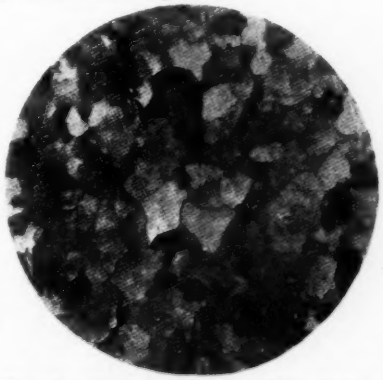

Fig. 2.—Chlorine-refined E11a Alloy, showing Surface Cracks and Large Grain.

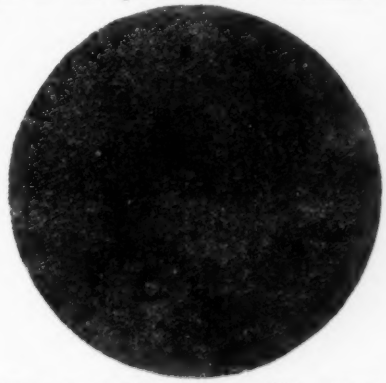

Fig. 3.—B.C.L.-refined E11a Alloy, showing Freedom from Cracks and Fine Grain.

* A Paper read before the Scottish Section of the Institute of British Foundrymen, Mr. N. McManus, M.B.E., presiding.

* *Vide* Paper given before the Institute of Metals, February, 1931.

possibilities of grain-size control in metals. As a result of separate application of the different processes there are two distinct types of metal, both of which have the same general analysis but possessing varying physical properties.

Products of Processes Compared.

If samples of these metals are subjected to a few simple casting operations, they will each behave differently. There is the normal or untreated metal; the chlorine treated metal; and the refined metal, known as B.C.L. refined metal—a simple abbreviation for boron trichloride. When small sand-cast blocks are sectioned, polished and etched for examination, the following points of difference will be noted between the types of metal. The unrefined metal will probably be full of pinholes and in consequence will be low in density. The surface of the block will be relatively flat and show little sink in the centre. This is caused by the evolution of dissolved gases during cooling, which balances the natural shrinkage. The chlorine-refined metal will be quite free from pinholes and will approach the maximum density. The surface will have a large sink or cavity at the centre. There may also be a central "pipe." The B.C.L. refined metal will be similar to the chlorine-refined metal with respect to soundness. The surface will not have such a deep sink as the chlorine-refined metal, while there will be no central "pipe" present, due to better feeding properties. This effect is caused by the absence of large crystals, which cause a bridging effect at the surface. The grain size will be very small.

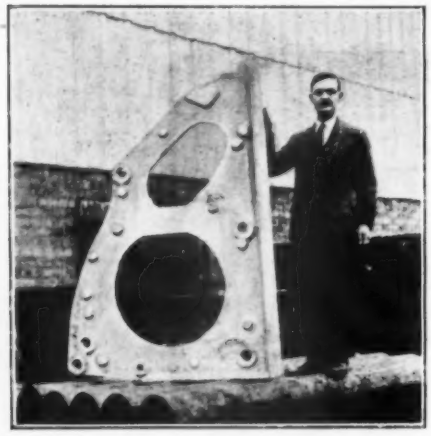

Fig. 4.—Large Frame Casting in B.C.L.-refined 2L5 Alloy.

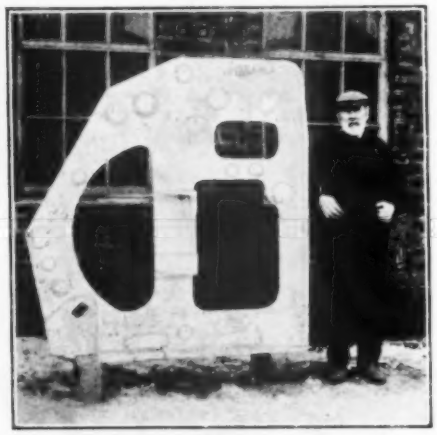

Fig. 5.—Large Frame Casting in B.C.L.-refined 2L5 Alloy.

If flat L-shaped plates are now cast, $\frac{3}{16}$ in. thick by about 12 in. long, in an aluminium-zinc alloy containing about 15 per cent. zinc and not more than 0.6 per cent. of other metals, one in normal metal and the other in B.C.L. refined metal, the one cast in the normal metal will consist of a mixture of large and small grains, and at the hotter parts of the mould will show a number of surface fissures or cracks, caused by the contraction of the metal at a point where feeding is not possible. This is the most common defect found in all castings having a flat surface and which are cast in the L5-type of alloy. On polishing and etching, it will be seen that the cracks follow the coarse-grain boundaries. Fig. 2 shows an example of grain-boundary cracks. When the casting is made in B.C.L. refined metal under exactly similar conditions, it will possess an extremely fine grain evenly throughout the casting, and will be quite free from surface fissures and cracks. Fig. 3 shows the same metal after B.C.L. refining. This is due to the fact that the casting sets progressively and under control.

A Practical Example.

Another interesting comparison can be obtained between the two metals by attempting to cast a long thin flat bar in green sand. A bar, measuring $\frac{3}{4}$ by $\frac{3}{16}$ in. by 4 ft., was cast from one end in normal metal. When the mould was opened it was found that the bar had cracked in five places. The longest piece was only 11 in. in length. When the same size of bar was cast in B.C.L. refined metal, it was found to be cracked only in one place, close to the runner. The unbroken length of the bar was 3 ft. 6 in. A more drastic test can be obtained by casting a double-ended T-piece, having rectangular steel bars moulded in between the T-pieces. The runner is placed opposite the long arm of the T and a riser of equal size is placed at the opposite end. In the normal metal, a large crack appears in the centre of the bar. This is due to the fact that normal contraction is not allowed to take place, caused by the presence of the steel bars. In the B.C.L. refined metal, there is no crack in the bar, and it will be found that the steel bars are tightly gripped by the ends of the T-piece.

A similar test can be carried out by casting the metal in the form of a thin border round an ordinary dry scone firebrick moulded in sand. The normal metal will be cracked in several places, but the refined metal will be free from cracks and will grip tightly round the brick. A number of similar but more practical tests have been carried out. For example, the casting of a large flat-frame, measuring 6 ft. by 4 ft. 6 in. by $\frac{3}{4}$ in. thick, and weighing nearly 3 cwts., in ordinary 2L5 alloy, B.C.L. refined. Figs. 4 and 5 show examples of flat castings. There are

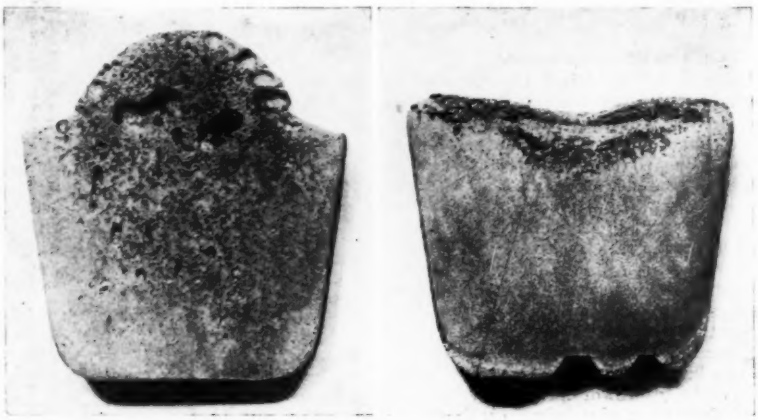

Fig. 6.—16 per cent. Cr/Al Ingot Gassed and Degassed with Chlorine.

Table I.—*B.C.L. Refining Applied to 2L5 Alloy.*

Test run on 2L5 test-bars. The metal used for this test was chosen purposely from impure scrap. It contained about 1.4 per cent. iron and about 0.2 per cent. lead. Seven cwt. was first melted and cast to ingots. One hundred-lb. heats were used for each test. The bars were cast in accordance with details given in Clause 8, B.E.S.A. Specification Book No. 363—1929. They were cast at 700 deg. C. into mould held at 300 deg. C. Two bars cast in each treatment, with following results :—

Test No.	Y.P. Tons per sq. in. At 0.1 in. per in.	M.S. Tons per sq. in.	E. Per cent. on 2 in.	Ratio. Y.T.E.	Remarks.
1	10.20	12.86	2.5	57.7	Normal alloy remelted. High yield due to oxides and impurities.
2	7.75	11.42	2.5	47.9	Remelted and treated with chlorine for 20 min. Yield point and maximum stress reduced due to increased grain size.
3	7.05	12.31	5.0	96.8	With addition of catalytic modifier only. Greatly improved elongation due to reduction in grain size.
4	10.24	12.40	3.3	74.7	With addition of catalytic modifier only, followed by chlorine treatment for 20 min. Improved yield but less elongation, due to increased grain size.
5	8.25	13.57	6.4	139.6	With addition of catalytic modifier, followed by chlorine for 15 min. and then followed by B.C.L. for 15 min. Improved yield point, maximum stress and elongation.
6	8.01	14.22	7.0	155.4	With catalytic modifier and fully treated B.C.L. Note yield point, high maximum stress along with high elongation.

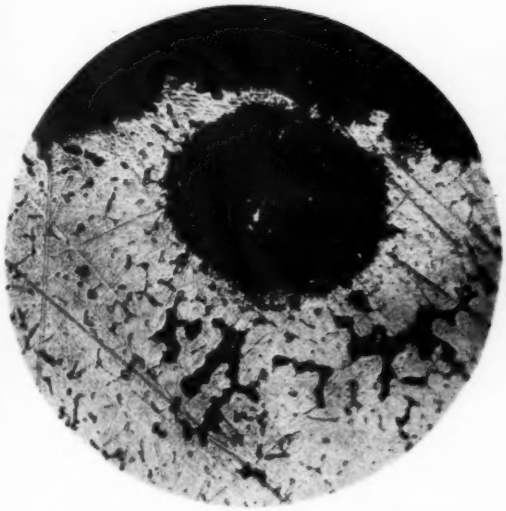

Fig. 7.—Surface Gas Cavity and Unsoundness Below.

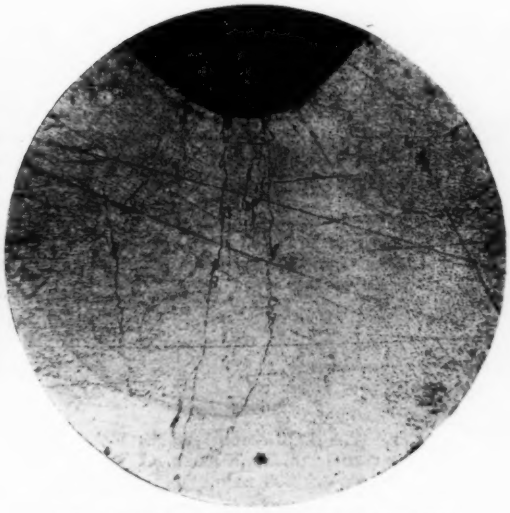

Fig. 8.—Bottom of Pipe and Soundness Below in Degassed Metal.

Fig. 9.—Normal Silicon-Aluminium Alloy. × 50 dias.

Fig. 10.—Chlorine-refined Silicon Alloy. × 50 dias.

Fig. 11.—Sodium-modified Silicon Alloy. × 50 dias.

Fig. 12.—Calcium-modified Silicon Alloy, showing Plates of $CaSi_2$. × 50 dias.

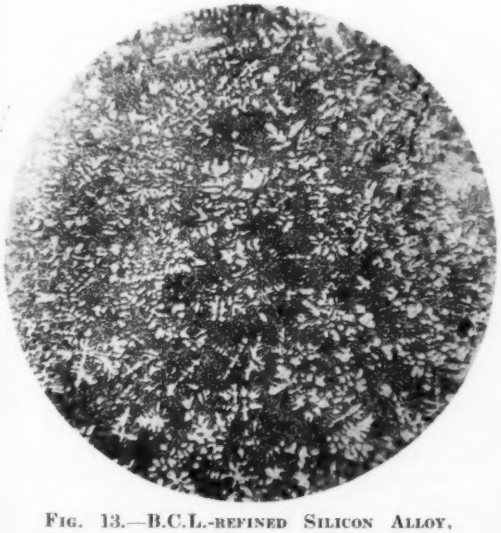

Fig. 13.—B.C.I.-refined Silicon Alloy.

Fig. 14.—Sodium-modified Silicon Alloy. × 500 dias.

Fig. 15.—Sodium-modified Silicon Alloy heated 1 hr. at 500 deg. C. and slowly cooled. × 500 dias.

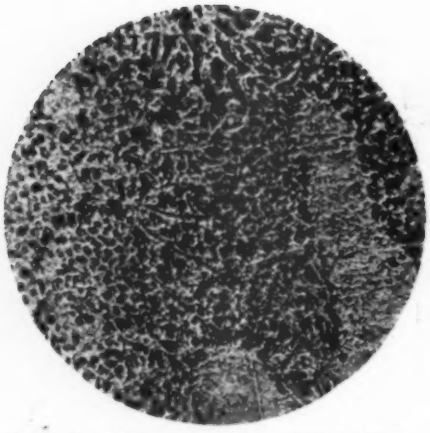

Fig. 16.—Normal B.C.L.-modified Silicon Alloy. × 500 dias.

Fig. 17.—B.C.L.-modified Silicon Alloy heated 1 hr. at 500 deg. C. and slowly cooled. × 500 dias.

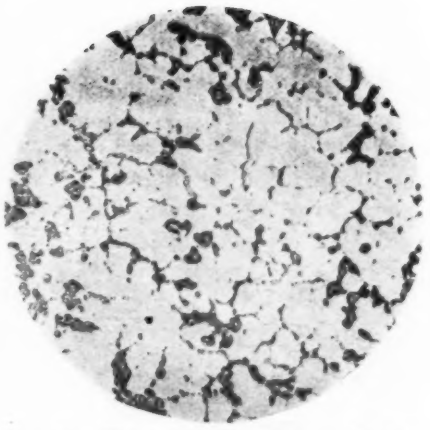

Fig. 18.—2L5 Alloy, Normal. × 50 dias.

Fig. 19.—2L5 Alloy, Slightly Refined. × 50 dias.

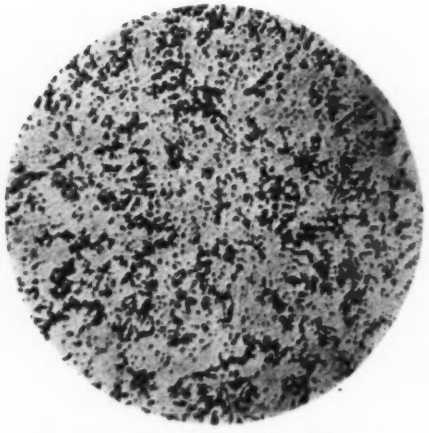

Fig. 20.—2L5 Alloy, More Refined. × 50 dias.

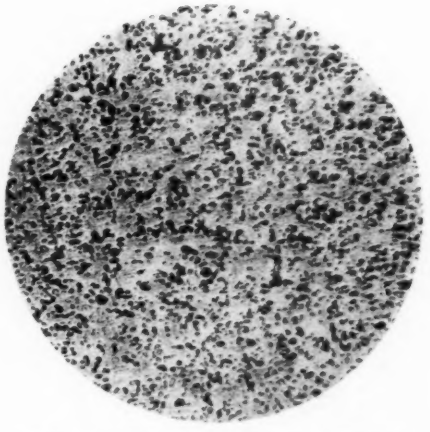

Fig. 21.—2L5 Alloy, Fully Refined. × 50 dias.

Fig. 22.—L11 Alloy, B.C.L. Refined.

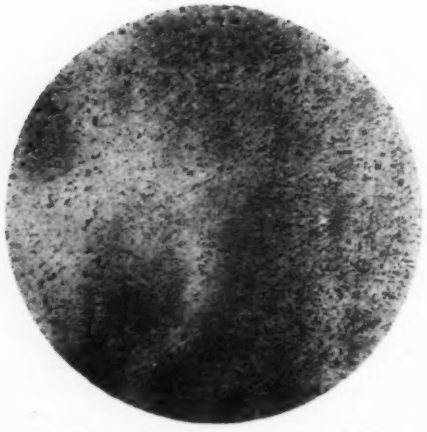

Fig. 23.—Duralumin, B.C.L. Refined. × 50 dias.

Fig. 24.—An 11 per cent. Silicon Alloy, Refined by the B.C.L. Process. × 50 dias.

many more similar applications which might be described, but no doubt these will readily suggest themselves to the practical foundryman. Before explaining from the more technical point of view the changes which are brought about by means of the B.C.L. refining process, it may be of interest to enumerate some of the advantages to be gained by employing refined metals in the foundry.

Advantages of B.C.L. Refined Metal in Sand Castings.

Melting.—Greater latitude is permissible in melting temperature as the metal is not easily damaged through overheating.

Casting.—Due to the grain-controlling properties, the metal can be cast over a wider range of temperature without any risk of causing a coarse structure. Greater fluidity increases the capacity to fill the mould more completely.

Setting in Mould.—Shorter freezing range causes more rapid freezing of the casting, and if proper chills are employed, the heavier sections can be set before the fluid metal feed is cut off. Due to the much smaller grain size, there is no risk of large primary crystals overhanging and the still liquid metal drawing away, thus leaving a cavity. The shorter freezing range also reduces the amount of feed metal required in the runner or riser. As the metal sets more rapidly, the heat imparted (*e.g.*, superheat) to the mould is much less proportionately as would be the case with a metal having a more extended freezing range. This results in a definite saving of metal in runners and risers.

Contraction in Mould.—Due to complete freedom from hot-shortness, it is not necessary to run the risk of damaging the casting by removal from the mould immediately after the metal has set. The saving in labour and attention as a result of this is very considerable.

Cleaning of Castings.—As the metal is considerably toughened as a result of the refining process, the resulting castings will withstand rough handling without risk of breakage. Flashes and small risers, etc., can be chipped off without the risk of breaking pieces out of the casting, as is the case with more brittle metals. Refined metals always produce a much cleaner casting.

Remelting.

The remelting of runners, etc., has no effect on the degree of refinement in the metal. It is possible to remelt the same lot of metal many times before a notable loss in physical properties takes place. At the same time, it may be said that it is easily possible to contaminate the metal with gases and oxide if the remelting operation is not properly carried out.

It may also be of advantage to point out some of the difficulties likely to be experienced in the foundry when changing over to gas-free and refined metals. The main difficulty experienced by casting refined alloys is that they are reputed to shrink more than ordinary metal. It is quite impossible to alter the true shrinkage of a metal. However, it is possible to alter the "apparent" shrinkage. Under normal conditions, liquid aluminium alloys, when passing into the solid state, will show a shrinkage of from 4 to 6 per cent. according to the pouring temperature. By bad melting conditions, undue contact with furnace gases, by stewing in the pot and too frequent stirring, it is possible to saturate the metal with gas and thus completely counteract the liquid shrinkage.

It is also possible to supersaturate the metal to such an extent that it will rise like bread when cast in an open mould. Fig. 6 shows a section of an ingot of badly-gassed metal and its removal by remelting and treating with chlorine gas. When the metal is being degassed, it is possible to draw off samples which exhibit all the known degrees of saturation. As degasification proceeds, the surface of sample ingots gradually subsides until only a slight surface exudation takes place. The action is similar in appearance to the well-known tin-sweat seen on the runner of a bronze casting. Finally, a stage is reached when the metal shows a very marked shrinkage cavity in the centre of the ingot. If the metal immediately below the cavity or pipe is quite sound then it can safely be concluded that the metal is gas free. Fig. 7 shows an example of unsoundness situated immediately below a gas cavity, whilst Fig. 8 is an example of complete soundness immediately below the "pipe" of a gas-free metal. In the foundry, the apparent feeding and mould-filling properties are very much affected by the amount of gas present in the metal.

Foundry Technique Necessary.

Using an alloy which in the first instance is gas saturated, the resultant casting may appear to be good, and on examining the feeding head, it will be seen to be comparatively flat. The

Fig. 25.—A 0.5 per cent. V. in 10 per cent. Silicon Alloy.

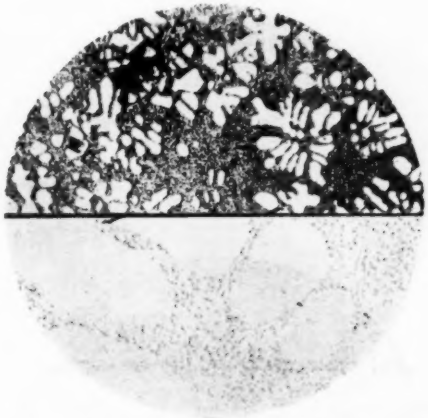

Fig. 26.—A 9 to 11 per cent. Silicon Alloy, B.C.L. treated, showing Coarsening Effect of $FeAl_3$.

Fig. 27.—A 9 to 11 per cent. Silicon Alloy, Sodium Modified, showing Coarsening Effect of $FeAl_3$.

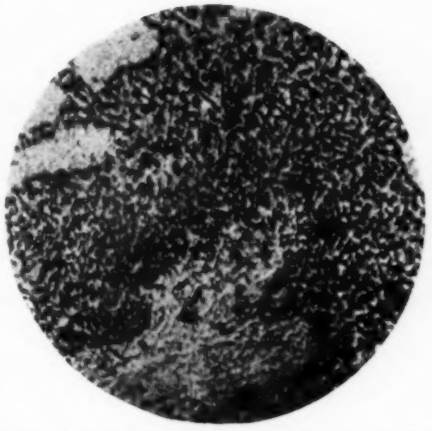

Fig. 28.—A 9 to 11 per cent. Silicon Alloy, B.C.L. Chill Cast, at 1,000 dias.

Fig. 29.—The $FeAl_3$ Network in 99.5 per cent. Aluminium Alloy.

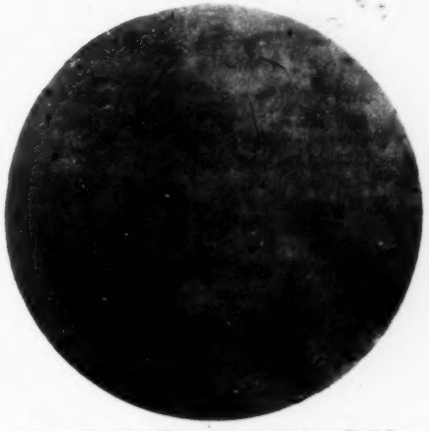

Fig. 30.—As Fig. 29, but after B.C.L. Refining.

inexperienced would say that the metal feeds well and has not much shrinkage. When this casting is followed through the machine shop, it is soon noticed that it is a mass of pin-holes. When returned to the foundry as a reject, its connection with the flat-runner head is probably not realised.

Using the same alloy, in the second instance completely free from gas, a deep pipe is seen in the runner, and, if the gates are not properly proportioned, a draw will be found somewhere in the casting. In this case the inexperienced would say that the metal draws badly and has much shrinkage. Actually, in the second instance, the good parts of the casting are very sound, while in the first instance all of the casting is bad and there are no good parts in it. The remedy for this is obvious, but it requires a great deal more foundry skill to be able to pour a good casting in gas-free metal which does not show a deep draw somewhere or other. However, when properly carried out, involving the use of properly-proportioned runners and risers, the resultant casting is one to be proud of, and may be depended upon in service.

Influence on Strength Properties.

When these differences are properly understood, the use of B.C.L. refined metals will enable the foundryman to produce better castings more often. Viewed from the purely metallurgical side, it is of interest to see what changes

Fig. 31.—A Bearing Metal of Normal Character.

Fig. 32.—A Bearing Metal after B.C.L. Refining.

are brought about in the internal structure and physical properties of alloys subjected to this refining process. When a metal is refined by the B.C.L. process, the most noticeable difference, apart from the removal of dissolved gases and other impurities, is a marked reduction in grain size. This effect alone has a considerable influence upon the physical properties of the metal. The ductility increases rapidly, and a test-bar may show as much as 200 per cent. increase in elongation. The impact value also rises proportionately, and may amount to as much as 300 per cent. If the process is continued, actual modification of the internal structure or eutectic will take place. This effect can be greatly accelerated by the introduction of certain elements, which act as powerful catalysts. These elements fall into a well-defined group, and include the elements scandium, titanium, vanadium, chromium, manganese, iron, cobalt and nickel. For convenience, they are termed catalytic modifiers, because they have the property of bringing about modification in a much shorter time of treatment. Used alone, they can only act as grain refiners, but used in conjunction with B.C.L. they can act as powerful modifiers, thus saving a more prolonged treatment with B.C.L. alone.

Producing Si-Al Alloys.

When it is desired to produce a modified silicon-aluminium alloy, three different methods may be employed, using the elements boron, calcium or sodium. For example, if a plain 10 per cent. silicon-aluminium alloy is made up from silicon dissolved in aluminium and sand-cast in a 1-in. dia. bar, its structure will consist of the normal coarse-silicon eutectic. Fig. 9 shows the normal silicon eutectic at 50 dias. If this alloy is remelted and treated with chlorine gas, in some cases a considerable refining action will be found to have taken place. Fig. 10 shows silicon alloy after treatment with chlorine gas at 50 dias. This does not always take place, and in some cases the silicon eutectic is much coarser than in the normal alloy. It is due to the presence or otherwise of minute traces of other elements and also to the presence of dissolved gases and other compounds, such as carbide.

When another quantity of the silicon alloy is treated in the molten state with about 5 per cent. of caustic soda, it will be found that it is well modified. The eutectic is now finely divided, and long dendrites of aluminium can be seen. Fig. 11 shows a sodium-modified silicon alloy at 50 dias. If another batch of metal is melted with the addition of 0.4 to 0.5 per cent. of calcium, it will again be found that the eutectic is well modified, but, on breaking the metal, it is found to be brittle and very little better than the normal alloy. This is due to the formation of the insoluble calcium disilicide compound, which crystallises in long thin plates, and this causes a plane of weakness in the alloy. Fig. 12 shows a calcium-modified silicon alloy showing thin plates of calcium silicide, at 50 dias.

B.C.L.—Modified Al-Si Alloys.

When another quantity of the metal is melted and treated with boron trichloride, it will again be found that it is well modified. In this case, however, grain refining also takes place, and results in complete absence of the long aluminium dendrites. Fig. 13 shows a B.C.L. refined silicon alloy. As a result of this, the alloy is much stiffer and has a higher yield point. When the modified alloys are re-melted and again sand-cast into 1-in. dia. bars, there will be a considerable difference between them.

The sodium-modified metal will have returned to the normal state, and its eutectic will become coarser. The calcium-modified metal will show little change in its eutectic, but it will be very unsound and full of small cavities, due to reaction with the furnace gases during melting. The boron-refined metal will be unchanged, its eutectic will remain in a finely-dispersed condition, and, if the metal has not been badly overheated, no unsoundness will be present. It is evident, therefore, that the B.C.L. refined metal is more permanent than either of the other two. If the refined alloys are heated to a high temperature and allowed to cool overnight in the furnace, a marked difference will be noted between the sodium- and B.C.L.-refined metal. The sodium-refined metal will be completely demodified while the B.C.L.-refined metal will be practically unchanged. Figs. 14 to 17 show the effect of heating the two differently-treated alloys to 500 deg. C. for one hour and cooling overnight in the furnace. The sodium-modified alloy is chill cast, while the B.C.L.-refined metal is sand cast. All are shown at 500 dias.

Elevated Temperature Service.

Under high-temperature service conditions, aluminium alloys are rarely called upon to exceed a temperature of 350 deg. C., and at this lower temperature the B.C.L.-refined metals remain unchanged after prolonged heating. When properly refined and modified, the silicon alloys will give a ductility up to 7½ per cent. elongation, as against the normal alloy, which has a ductility of about 2 per cent. in the sand-cast state. When the 2L5-type of alloy is treated by the B.C.L. process, the same degree of improvement can be obtained. In one example, a high-iron stock alloy was treated by various processes in order to define the best treatment required. This alloy contained the normal percentages of copper and zinc along with 1.4 per cent. iron and 0.25 per cent. lead. B.E.S.A. test-bars were cast in accordance with details given in Clause 8, 1929. The metal was cast at 700 deg. C. into the mould held at 300 deg. C. in each case. Proper treatment resulted in an increase from 12.8 to 14.2 tons in maximum stress along with an increase from 2.5 to 7 per cent. elongation. Table I gives details of this test. Metal of normal purity and containing not more than 0.7 per cent. iron and not more than 0.05 per cent. lead will naturally give very much better results. Figs. 18 to 21 illustrate the progressive refinement obtained during treatment with B.C.L. at 50 dias. The test-bar from the last example gave a maximum stress of 15.6 tons along with 12.4 per cent. elongation. The metal was of B.E.S.A. purity. When the copper-aluminium alloys such as L11 and L8 are treated by this process, it is extremely difficult at present to bring about proper refinement. Fig. 22 shows a B.C.L.-refined L11 alloy at 50 dias. The most notable improvement in this type of alloy is a marked increase in impact value.

The lower-copper alloys containing about 4 per cent. copper, *e.g.*, Duralumin, "Y," or 258, etc., are much more easily refined, and in the case of the Duralumin type a high degree of dispersion can be obtained by B.C.L. refining. This is explained by the presence of manganese in the alloys, which acts as a catalytic modifier. Fig. 23 is a good example of B.C.L.-refined Duralumin at 50 dias. These types of alloys are all used in the heat-treated condition, therefore a process which causes fine dispersion of the particles prior to heat-treatment is of great value, as the time of treatment is very considerably reduced.

High Purity Alloys.

Some very interesting results have been obtained from the high-purity silicon alloys; for instance, alloys containing no other metals than aluminium, silicon, iron and those intentionally added. All aluminium alloys contain traces of copper, manganese, titanium, etc., which have an important effect on refining processes. In order to determine what elements aid or hinder refining, none other than those intended must be present. When a 10 per cent. silicon, 0.4 per cent. iron alloy is refined by the B.C.L. process, modification takes place slowly and it is necessary to apply the process for a considerable time in order to obtain complete refinement. At one stage of the process the silicon particles become so finely and evenly divided that it is impossible to distinguish the fracture from that of fully-modified metal. In this way it is possible to obtain 7 per cent. elongation from the metal without true modification having taken place. Fig. 24 shows at 50 dias. this metal and

(*Concluded on page* 328.)

Steel Tub Wheels for Use in Mines.

BRITISH STANDARD SPECIFICATION.

The British Engineering Standards Asso-ciation has just issued B.S.S. No. 413—1931 for steel tub wheels and axles (fixed-running and self-oiling) for use in mines.

This Specification has been based on the replies received to a questionnaire circulated to collieries to ascertain the existing position, which showed that there were over 3,000 types and sizes in use. These have been reduced in the present Specification to 25. The replies received showed that fixed-running wheels were used in 90 per cent. of the tubs in use, while of the other types 82 per cent. were of the self-oiling type. These two types have, therefore, been provided for in the Specification. It was also shown that curved spokes were used in 80 per cent. of the wheels in use, and as this type of wheel facilitates casting, it has been adopted. Sixty-two per cent. of the wheels used were found to be made of cast steel and 36 per cent. of manganese steel. Alternative specifications for these materials have therefore been included.

Figs. 1 and 2 show sectional elevations of the fixed-running wheels and self-oiling wheels, whilst Tables I and II give the respective dimensions for various diameters, etc.

Regarding cast-steel wheels, the Specification states that they shall not show on analysis more than 0.08 per cent. of sulphur and 0.08 per cent. of phosphorus, and the manufacturer shall supply an analysis of each cast when required to do so by the purchaser. The wheels shall be annealed at a temperature not less than the normalising temperature, and be allowed to cool slowly from the maximum temperature in a practically uniform manner. When required by the purchaser, separate test-bars shall be cast from the same charge as the wheels or pedestals. A standard test-piece (having a gauge length of 3 in. and a parallel length of not less than 3¾ in., 0.798 in. dia.) shall be machined from each of the test-bars, which shall show a minimum tensile breaking strength of 35 tons per sq. in., with an elongation of not less than 10 per cent.

One per cent. of the wheels may be selected indiscriminately from the bulk and tested in the following manner:—The wheel shall be allowed to fall freely in a running position from a height of 10 ft. on to a block of metal weighing not less than 5 tons and supported on a rigid foundation, after which the wheel should show neither fracture nor deformation. The wheel may then be submitted to a hammering test on the tread, and should stand flattening by an amount equal to one-twelfth of its diameter without fracture.

Wheels made of manganese steel shall show on analysis not less than 11 per cent. of manganese. The manufacturer shall supply an analysis of each cast when asked to do so. All castings shall be subject to a water-toughening process by being heated at a temperature not less than 1,000 deg. C., and then being plunged at that temperature into cold water. The castings shall then be non-magnetic when tested with an ordinary horse-shoe magnet. When required by the purchaser, separate test-bars, 6 in. long by ¾ in. wide by ½ in. in thickness, shall be cast from the same charge as the wheels. The test-bars shall be capable of being bent round a bar 2-in. dia. through an angle of 45 deg. without fracturing.

The falling and deformation tests are the same as for cast steel.

The axles shall be rolled to the specified diameter from steel made by the open-hearth process. One per cent. of the axles may be selected indiscriminately from the bulk, and, using the Standard test-piece, shall give a minimum tensile breaking strength of 35 tons per sq. in., with an elongation of not less than 15 per cent.

The complete Specification may be obtained from the British Engineering Standards Association, 28, Victoria Street London, price 2s. net, post free 2s. 2d.

TABLE I.—*Dimensions of British Standard Fixed-Running Tub Wheels for Use in Mines.*

A		B	C	D	E	F	G	H*	J	K	L	M	N	No. of Arms.	Approx. Weight.
in.	mm.**	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.		lb.
8	203·2	¾	9/32	2	7/16	2 1/16	2⅝	1⅝	2 3/16	7/32	9/32	1¾	2 5/16	5	13
9 Light	228·6	¾	—	2¼	7/16	2 1/16	2¾	1½	3 1/16	—	—	2	2 5/16	5	14
9 Medium	228·6	¾	9/32	2¼	7/16	2 1/16	2¾	1½	3 1/16	7/32	9/32	2	2 5/16	5	15½
9 Heavy	228·6	¾	—	2¼	7/16	2 1/16	2¾	1½	3 1/16	—	—	2	2 5/16	5	17
9½	241·3	¾	9/32	2¼	7/16	2 1/16	2¾	1½	3 1/16	7/32	9/32	2	2 5/16	6	17
10 Light	254·0	¾	—	2¼	7/16	2 1/16	2¾	1½	3 1/16	—	—	2	2 5/16	6	17
10 Medium	254·0	¾	5/16	2¼	7/16	2 1/16	2¾	1½	3 1/16	¼	5/16	2·	2 5/16	6	19
10 Heavy	254·0	¾	—	2¼	7/16	2 1/16	2¾	1½	3 1/16	—	—	2	2 5/16	6	21
10½	266·7	¾	11/32	2¼	15/32	2 23/32	2⅞	1⅝	3 5/32	9/32	11/32	2	2 5/16	6	21
11	279·4	¾	⅜	2¼	15/32	2 23/32	2⅞	1⅝	3 5/32	5/16	⅜	2	2 5/16	6	23
11½	292·1	¾	⅜	2¼	15/32	2 23/32	2⅞	1⅝	3 5/32	5/16	⅜	2	2 5/16	7	25
12 Light	304·8	¾	—	2¼	15/32	2 23/32	3	1¾	3 5/32	—	—	2	2 5/16	7	23½
12 Medium	304·8	¾	⅜	2¼	15/32	2 23/32	3	1¾	3 5/32	5/16	⅜	2	2 5/16	7	26
12 Heavy	304·8	¾	—	2¼	15/32	2 23/32	3	1¾	3 5/32	—	—	2	2 5/16	7	28½
13	330·2	1	⅜	2½	½	3	3	1¾	3⅜	5/16	⅜	2 5/16	2⅝	7	33
14	355·6	1	13/32	2½	½	3	3½	2	3⅝	11/32	13/32	2 5/16	2⅝	7	38
15	381·0	1	7/16	2½	17/32	3 5/32	3½	2	3 13/32	⅜	7/16	2 5/16	2⅝	7	43

TABLE II.—*Dimensions of British Standard Colliery Self-Oiling Tub Wheels.*

A		B	C	D	E	F	G	H	J	K	L	M	N	O	P	No. of Arms.	Approx. Weight.
in.	mm.*	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.		lb.
10	254·0	¾	5/16	2½	7/16	2 15/16	2¾	1½	3⅜	1½	1 5/16	4½	2⅛	¼	5/16	6	25
11	279·4	¾	⅜	2½	15/32	2 31/32	3⅛	1¾	4	1⅝	1 1/16	5	2¼	5/16	⅜	6	33
12	304·8	¾	⅜	2½	15/32	2 31/32	3⅛	2	4½	1⅝	1 1/16	5⅜	2¼	5/16	⅜	7	39½
13	330·2	1	⅜	2½	½	3	3½	2	4½	1⅝	1 1/16	5⅜	2¼	5/16	⅜	7	43
14	355·6	1	13/32	2¾	½	3¼	3½	2	4½	1⅝	1 1/16	5⅜	2½	11/32	13/32	7	49
15	381·0	1	7/16	2¾	17/32	3 9/32	3½	2	4½	1⅝	1 1/16	5⅜	2½	⅜	7/16	7	55
16	406·4	1	7/16	2¾	17/32	3 9/32	3½	2	4½	1⅝	1 1/16	5⅜	2½	⅜	7/16	7	58
17	431·8	1	7/16	3	17/32	3 13/32	3¾	2¼	5	1⅝	1 1/16	5⅞	2¾	⅜	7/16	7	68½

* The figures in British measures are to be regarded as standard. Approximate metric equivalents are given for the convenience of users in countries in which the metric system has been generally adopted.

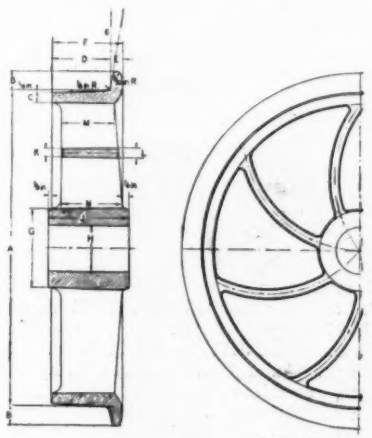

FIG. 1.—BRITISH STANDARD FIXED-RUNNING STEEL TUB WHEEL FOR USE IN MINES.

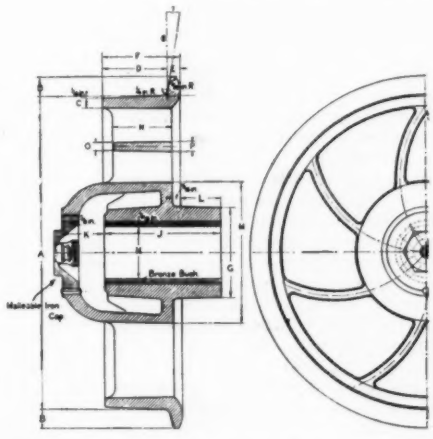

FIG. 2.—BRITISH STANDARD COLLIERY SELF-OILING TUB WHEELS.

Institute of British Foundrymen.

ANNUAL CONFERENCE AT BIRMINGHAM, JUNE 9 TO 12, 1931.

As previously announced, the twenty-eighth annual conference will be held in Birmingham from June 9 to 12, 1931. A feature of the conference is the visit to Coventry, the home city of the President-Elect, and where there is much of real interest, both industrial and historical. It will be remembered that the Institute was originally founded in Birmingham, and conferences have been held in that city in 1909 and 1922. It is hoped to show members attending the conference some of the widely divergent foundry activities in the Midlands, whilst some of the rural and historic beauty spots of the district will also be visited.

The railway companies have again granted special concessions to those participating in the conference, and single fare and one-third bookings for the double journey (fraction of 3d. reckoned as 3d.), upon surrender at the time of booking of the vouchers obtainable from the general secretary, have been made available. The tickets will be utilisable from June 8 to 13.

PROGRAMME.

Tuesday, June 9.

4.0 p.m.—Council meeting at the Grand Hotel, Birmingham.

8.30 p.m.—Reception by the Lord Mayor and the Lady Mayoress of Birmingham (Alderman and Mrs. W. W. Saunders) at the Council House (evening dress optional).

Wednesday, June 10.

9.15 a.m.—Conference opens at the Grand Hotel. Official welcome by the Right Worshipful the Lord Mayor of Birmingham (Alderman W. W. Saunders, J.P.) (ladies invited).

9.30 a.m.—Annual general meeting, open to all members, associate members and associates; election of officers, etc.

10.30 a.m.—Presidential address by Mr. A. Harley.

10.50 a.m.—Discussion of Papers, Nos. 478 to 484.

12.30 p.m.—Conference adjourns.

12.45 p.m.—Luncheon at Lewis's, Limited, Corporation Street.

2.0 p.m.—Omnibuses leave Minories for the following works visits:—(1) F. H. Lloyd & Company, Limited, James Bridge Steel Works, near Wednesbury (steel castings); (2) W. & T. Avery, Limited, Soho Works, Birmingham (general engineering castings; historical associations of Boulton, Watt and Murdoch); (3) Henry Wiggin, Limited, Wiggin Street, Birmingham (manufacturers of nickel and nickel alloys, cobalt refiners); (4) Austin Motor Company, Limited, Northfield (the foundry, which manufactures iron, steel and non-ferrous castings for automobile construction, has recently been completely mechanised); (5) Midland Electric Manufacturing Company, Limited, Barford Street, Birmingham (manufacturers of electrical switch and fuse gear; ironfoundry working on mass-production methods, porcelain-insulation manufacture and assembly shops). Members are also invited to visit the laboratories of the British Cast Iron Research Association, 24, St. Paul's Square, Birmingham, where special demonstrations are being arranged during the conference.

7.0 p.m.—Annual banquet, followed by a dance until 1 a.m., at the Grand Hotel (evening dress optional).

AT COVENTRY.

Thursday, June 11.

9.30 a.m.—Omnibuses leave Grand Hotel, Birmingham, for Coventry.

10.30 a.m.—Civic welcome at St. Mary's Hall, Coventry, by His Worship the Mayor of Coventry (Alderman W. H. Batchelor).

10.45 a.m.—Conference continues. Paper on "The Relationship between the Engineering and the Foundry Trades," by Mr. L. H. Pomeroy (managing director, Daimler Company, Limited) (Paper No. 485). This Paper will be read *in extenso*. Discussion of Papers Nos. 485 and 486.

1.0 p.m.—Luncheon at the Masonic Hall, Coventry (by invitation of the Birmingham, Coventry and West Midlands Branch).

2.15 p.m.—Omnibuses leave the Masonic Hall for the following works visits:—(1) Daimler Company, Limited, Coventry (iron, steel and non-ferrous castings for the automobile and allied trades); (2) Sterling Metals, Limited, Foleshill (grey-iron and non-ferrous castings, sand and die, for the automobile trade); (3) Morris Motors, Limited, Coventry (a large "continuous-flow" foundry engaged chiefly on automobile cylinders, and probably the most completely mechanised foundry in Great Britain); (4) Alfred Herbert, Limited, Coventry (grey-iron castings for machine tools; a modern machine shop); (5) British Piston Ring Company, Limited, Foleshill (centrifugal and sand-cast piston rings and liners).

7.0 p.m.—Informal entertainment and supper at the Masonic Hall, Coventry.

9.45 p.m.—Return to Birmingham, arriving about 10.30 p.m.

Friday, June 12.

9.45.—Motor-coach excursion to the Cotswold country (omnibuses leave the Grand Hotel); lunch at Cheltenham; tea at Chipping Campden.

LADIES' PROGRAMME.

Tuesday, June 9.

8.30 p.m.—Reception at Council House.

Wednesday, June 10.

10.30 a.m.—Ladies assemble for coffee at Kunzle's Café, Union Street, and then visit places of interest in Birmingham.

12.45 p.m.—Luncheon at Lewis's, Limited, Corporation Street.

2.0 p.m.—Omnibuses leave Old Square for:—(1) Cadbury's, Limited, Bournville (the well-known Garden City and chocolate factory); (2) Tomkinsons, Limited, Kidderminster (carpet works).

7.0 p.m.—Annual banquet and dance.

AT COVENTRY.

Thursday, June 11.

9.30 a.m.—Omnibuses leave Grand Hotel, Birmingham, for Coventry.

10.30 a.m.—Civic welcome by Mayor of Coventry at St. Mary's Hall.

10.45 a.m.—Tour of historic places in Coventry.

1.0 p.m.—Luncheon at Masonic Hall.

2.15 p.m.—Omnibuses leave for Kenilworth Castle, Warwick Castle, Guy's Cliff and Leamington (tea).

7.0 p.m.—Informal entertainment and supper at Masonic Hall.

9.45 p.m.—Omnibuses leave for Birmingham.

PAPERS TO BE PRESENTED AT THE CONFERENCE.

Wednesday, June 10.

(Duplicate sessions will be arranged.)

Session A.—No. 478, American Exchange Paper, "The Effect of Elevated Temperatures on Grey-Iron Castings," by G. W. Spring, Chicago, U.S.A.; No. 479, Belgian Exchange Paper, "Factors in the Conductivity of Irons," by Prof. H. Thyssen, University of Liège; No. 480, French Exchange Paper, "The Laboratory and the Foundry," by Mr. R. Arzens; No. 481, "The Merchandising of Castings," by Mr. Eric N. Simons (Edgar Allen & Company, Limited).

Session B.—No. 482, "Sands and Sand Testing," by Dr. J. G. A. Skerl, D.Sc. (member), British Cast Iron Research Association; No. 483, "Silicon as an Alloying Element," by Mr. John Arnott, A.I.C. (member), G. & J. Weir, Limited, Glasgow; No. 484, "High-Duty Light Alloys," by Mr. W. C. Devereux (High Duty Alloys, Limited).

Thursday, June 11.

No. 485, "The Relationship between the Engineering and the Foundry Trades," by Mr. L. H. Pomeroy, M.I.Mech.E., M.I.A.E. (managing director, Daimler Company, Limited) (this Paper will be read *in extenso*); No. 486, "Recent Developments in Cast Iron in Great Britain," by Mr. J. G. Pearce, M.Sc., M.I.E.E. (member), director, British Cast Iron Research Association.

Conference Office and Information Bureau.—The office will be open for issue of tickets, booklets, copies of Papers, etc., as follows:—Tuesday, June 9, 2.0 p.m. to 8 p.m., at the Grand Hotel; Wednesday, June 10, 9.0 a.m. to 12 noon, at the Grand Hotel; and Thursday, June 11, 10.30 a.m. to 12 noon, at St. Mary's Hall, Coventry.

The Use of Refined Metals in the Foundry

(*Concluded from page* 326.)

illustrates the evenness of the dispersion. Certain elements, when added to the silicon alloys, will prevent modification from taking place. Both copper and vanadium have this effect. When 0.5 per cent. vanadium is added to the 10 per cent. silicon alloy prior to refining, very poor results are obtained and the silicon eutectic becomes coarse, as is shown by Fig. 25. The presence of iron in the silicon alloys, although extremely harmful when the metal is being modified by the sodium method, has but little effect when the metal is modified by the B.C.L. process. This is due to the fact that the FeAl, or x compounds do not appear as thin plates as is the case with sodium modification. The B.C.L. refining causes a well-dispersed condition of the $FeAl_n$ etc. Fig. 26 illustrates at 50 and 500 dias. the formation of the iron compounds in a B.C.L.-refined silicon alloy, and is to be compared with Fig. 27, which illustrates the effect of modifying a similar iron-rich alloy with sodium. The FeAl, appears in this case as very pronounced thin plates. This results in a very weak metal, having a coarse crystalline fracture. By proper application of the B.C.L. process it is possible to obtain the silicon particles in a finer state of dispersion than by any other method. Fig. 28 is an example at 1,000 dias. of B.C.L. silicon alloy. The actual size of the silicon particles in this specimen are approximately 1/1,000 mm. in diameter. When high-purity aluminium is treated by the B.C.L. process the normal $FeAl_3$ network becomes completely broken up into fine nodular particles. Fig. 29 is an example at 50 dias. of normal $FeAl_3$ network in aluminium of 99.5 per cent. purity. Metal of this purity being extremely soft, it is very difficult to obtain a specimen free from scratches. Fig. 30 shows the same metal after B.C.L. refining. In this case there are practically no scratches. This is due to the fact that the metal is slightly harder, has a fine grain and is free from unsoundness. There are no voids for the abrasive to lodge in and then fall out at a later stage of the polishing, thus causing a scratch. It will be seen that the normal network has entirely disappeared and has been replaced by a number of small nodular particles. This results in greatly increased ductility and shock resistance. Figs. 31 and 32 illustrate the application of the B.C.L. process to an ordinary lead-tin-antimony bearing metal. The same general improvement can be noted as is the case with the aluminium alloys. These remarks also apply to the copper-zinc alloys. In conclusion, when the process is more thoroughly understood and applied, there will be many more interesting metallurgical phenomena to examine and describe.

The Surface Treatment of Aluminium and its Alloys.

(*Continued from page* 302.)

Chemical Methods of Surface Protection.

In all chemical methods, if aluminium alloys and not the pure metal are being treated, due consideration must be given to the nature of the alloys.

Pure Chemical Processes.

Ornamental Finishing—Matting or Frosting.—A matt or frosted finish on aluminium is produced by dipping the metal first in an alkaline and then in an acid pickle, the latter being necessary to remove the black deposit which the alkaline dip generally produces. The alkaline pickle is usually caustic soda of strength not less than 10 per cent. by weight, at about a temperature of 95 deg. C. Two cold-water rinses are necessary before dipping in the acid bath, which consists of a mixture of acids, sulphuric and phosphoric (9 : 1)—about 2 per cent. by weight—or in cases where the black scum is not readily removed, sulphuric and nitric (1 : 1) of greater strength. The metal has then to be thoroughly rinsed first with cold and then with hot water, and dried with hot sawdust.

Immersion Processes—Colouring.—By colouring is meant here not the strictly chemical sense of the word—for aluminium this is impossible, as no coloured compounds of aluminium exist, and the "colouring" is therefore dependent on the presence of other metals—copper, nickel, iron, etc. Most of the processes devised do not come under the pure chemical heading, being dependent either on electrolytic deposition of the colour-giving metal, or on an anodic production of an oxide film which is subsequently dyed either with aniline dyes for indoor service or mineral colours (cobalt salts, etc.) for outdoor service. The methods which may be called chemical belong to the group of chemical immersion processes. A dead-white coating can be given to aluminium by boiling it in "milk of lime" which contains a little $CaSO_4$ and subsequently baking. The coating adheres very firmly and does not remove on bending; it cannot be rubbed off by the fingers, but a pencil eraser removes it. The texture is extremely fine-grained and the surface can be enamelled or painted, or sized if required for ink.[3] The Jirotka process for producing a coloured film on aluminium by immersion in a bath of an aqueous solution of chromates, etc., and salts has been in use for some time, and a recent patent[4] provides a modification, the bath consisting of chromates or dichromates or both in alkaline solution, with or without addition of metallic salts. The action of the alkali is to dissolve away the aluminium to a certain depth, the chromate then producing a uniform dispersion of the alloying constituent exposed.

Various baths have been compounded to give a black finish, some of the solutions being very complex. The following methods are typical: (*a*) The surface is treated with copper ammonium chloride and heated to produce copper oxide. The surface is subsequently treated with sodium sulphide, or lampblack is rubbed in;[5] (*b*) bath treatment is given with nickel sulphate 10 gr., sodium fluosilicate 5 gr., potassium nitrate 25 gr., water 2 litres; (*c*) the surface is treated with ammonium molybdate;[6] (*d*) bath treatment is given with tannin and the metal is heated gently—the finish imparted is dull black, and (*e*) after an acid dip in 3 : 1 H_2SO_4, the metal is treated with a mixture consisting of 150 gr. antimony bichloride, 100 gr. manganese nitrate, 20 gr. graphite, and 250 gr. HCl in 1 litre 90 per cent. alcohol. It is then coated with a varnish made up of 50 gr. Sandarak and 100 gr. Nigrosin in 1 litre spirit.

A "smoke" finish can be given to aluminium by the following method. The metal is first lacquered with gum lacquer and is then supported over a smoky gas flame. On cooling, the surface is treated with boiled linseed oil. An "oxidised" finish, which makes aluminium resemble oxidised silver, is produced by dipping in a bath containing 2 ozs. arsenic, 1 oz. iron sulphate, 2 ozs. copper sulphate in 1 gall. HCl (the specific gravity of the bath should be about 1.115 (15 deg. Be)).[7] A trade process registered under the name of "Panalumin," which depends on bath treatment, may be applied to producing coloured surface effects.

Immersion Processes—Metal Plating.—The methods of non-electrolytic plating of other metals on aluminium depend again on the use of special baths; they are few in number. *Copper.*—A copper coating may be produced by treating with boiling copper nitrate for a short time, washing and treating with a boiling bath of concentrated copper sulphate for 15 to 30 min. The articles must be transferred rapidly between the different baths and not exposed for any length of time to the atmosphere. Immersion in a mixed solution of copper sulphate and acetate also produces a copper coating.[8] *Lead.*—Aluminium plates are coated with lead chlorides and urea. When this mixture is heated on the aluminium the lead forms a firmly-adherent coating in which any aluminium which penetrates the coating is rendered passive and not readily oxidisable.[9]

Immersion Processes — Oxidising. — A recent patent[10] has been applied for to cover a process of producing an oxide film on aluminium by immersion in an aqueous solution of an alkali together with a catalyst, with or without ammonia. A suitable bath is given as 2 to 6 per cent. NaOH, 1.5 to 3 per cent. ammonia and 2.5 to 12 per cent. of a catalyst, preferably sodium silicate.

Immersion Processes.—Miscellaneous.—A number of special processes have been brought out from time to time to provide for the surface protection of aluminium by producing coatings frequently of a complex nature. Some examples are: (1) The metal surface is treated with a lac or varnish with a synthetic resin base and containing free phenol. The phenol attacks the metal and produces a protective layer of crust;[11] (2) the aluminium is immersed in a boiling bath containing a vanadate, molybdate, tungstate, titanate, uranate, niobate, manganate, etc., or a mixture of these salts, and an alkaline carbonate or the corresponding alkali hydroxide. The process is patented in France under the trade name of "Protalisation";[12] (3) another bath formula consists of a 1.5 per cent. solution of equal parts of pot. dichromate, caustic soda and alum (the bath is used at 90 to 95 deg. C.), and (4) mild alkaline bath treatment is sometimes used; one such bath consists of 25 grms. pot. carbonate, 25 grms. sod. bicarbonate, and 10 grms. pot. bicarbonate in 1 litre water and is used hot.

Physico-Chemical Methods.

Diffusion Processes.—Some experimental work has been carried out to obtain a coating of zinc on aluminium by heating in contact with a suitable mixture, but the process has not yet passed the laboratory stage.

Cementation.—A process exists[13] for the cementation of aluminium by copper. The copper is first deposited on the aluminium (by electrolytic or other means) and is then heated in the electric furnace in a neutral atmosphere. No appreciable cementation takes place below 544 deg. C. (the formation temperature of the eutectic Al_2Cu in solid solution), and for any appreciable penetration the heating must increase to nearly the melting point of aluminium.

Oxidation by Heating.—Simple heating in air produces a thin oxide film on aluminium and its alloys, and heating to 100 to 200 deg. C. has been applied to zinc and cadmium coatings on aluminium to give rise to the formation of oxide films.

Electro-Chemical Methods.

Most of the important methods of surface treatment of aluminium are dependent on electro-chemical processes.

Anodic Oxidation.—When aluminium is made the anode in a suitable electrolyte, it becomes coated with a uniform, fine-textured, hard and adherent oxide film. The structure of the film contains fine pores, allowing the passage of the current, so that theoretically the process may be continued to produce a film of any required thickness, but, according to recent work on the thickness of the film in relation to breakdown, a practical limit (in the region of 70 μ) exists, above which the pores do not allow of equal current density over the whole surface, the film consequently being no longer uniform. Different explanations have been given of this formation by electrolysis of aluminium oxide:—(*a*) *Chemical*, that aluminium goes into solution in nascent hydrogen and precipitates the hydroxide; (*b*) *electro-chemical*, depending on the nascence at the (aluminium) anode of oxygen, which combines with the hydrogen generated, hence giving rise to hydroxide formation, and (*c*) *electrical*, in that the gaseous films forming are continually undergoing a breakdown effect, giving rise to temperatures sufficiently high to age and harden the hydroxide even to the extent of forming ultimately a crystalline aluminium oxide.

Anodic treatment is applicable not only to aluminium but to most of its alloys, except those with a copper content of more than 5 per cent., and the metal may be either heat-treated or aged or in the annealed condition. The modifications of the process depend on the use of different electrolytes:—

(*a*) *Bengough's Method.*—The electrolyte is in this case 3 per cent. aqueous chromic-acid solution. The voltage is raised from zero to 40 in the first 15 minutes, kept at 40 for 35 minutes, raised to 50 in the next five minutes and kept at 50 for five minutes; (*b*) *Stafford O'Brien Method.*—The electrolyte is a solution of a chloride in H_2SO_4; (*c*) *Jirotka Method.*—The electrolyte is a solution of HNO_3 of not less than 25 per cent., and (*d*) *Setoh and Miyata Method.* The electrolyte is a dilute solution of oxalic acid. In this method the anode metal (the aluminium) has a tendency to become pitted if the circulation of the electrolyte is not perfect; this difficulty is overcome by superimposing a.c. to d.c. during electrolysis and adjusting the alternating voltages suitably.

The choice of method and the conditions of treatment are governed by the use for which the metal is required. The English processes are generally used for protective purposes, and the process of Setoh and Miyata is generally used for electric insulation. If the oxide film is required to be protective, it is much improved by subsequent application of a suitable paint, enamel or grease. The ageing and deposition of the oxide can be increased by treatment with superheated steam, for protective purposes, but for electrical insulation, the film is thereby rendered too brittle. A new process of electric oxidation has recently been developed by the Vereinigte Aluminium Werke—Eloxal. Details

3 Westinghouse Electrical & Manufacturing Company.
4 Pacz. E.P. 338,204.
5 British Aluminium Co.
6 F. A. Roux. U.S.P. 1,095,357.
7 J. A. Haslip.
8 M. O. Herchmann. U.S.S.R.P. 39,783.
9 O. F. Reinhold. U.S.P. 1,362,739 (1921).
10 British Thomson-Houston Company. E.P. App. 20,802 (1930).
11 E. Michel. U.S.P. 1,754,481.
12 C. Boulanger. E.P. 342,256 (1929).

of the method are not available, but the electric insulation has a much greater range than with other methods, a dielectric strength up to 10,000 volts being producible. The coating is extremely hard and chemically resistant in addition.

Electro-Deposition.—Much research has been carried out on electro-deposition to study the causes of the difficulties which are encountered and to be able to combat them. The theory of electro-deposition is still a somewhat controversial subject. Deposition may be considered to be due to (*a*) mechanical conjunction and (*b*) physical conjunction, and some metallurgists consider the former—mechanical hooking or interlocking—to be sufficient to produce deposition; while others consider physical conjunction to be the primary phenomenon to mechanical conjunction is merely an auxiliary to adhesion. Physical conjunction is dependent on two phenomena—cohesion and diffusion. Cohesion, the dominant phenomenon, produces intimate atomic or molecular contact of the two bodies in contact, which gives rise to the formation of alloys at the contact plane of the deposit and base metal, and to the continuation in the deposit of the crystal structure of the base metal. Diffusion, the agent which enables cohesion to operate, produces intermingling of the atoms or molecules of the two bodies.

The mechanism of adhesion is probably as follows:—Embryonic crystals of the deposited metal form and are attracted (cohere) to the atoms of the cathode metal, either on the walls of the pores or on the surface outside the pores, forming a thin primary layer of deposited metal intermixed with the metal of which the cathode consists; this layer becomes widened by diffusion. The cohesion may take place between the atoms of any solid body, whether they are of different or similar chemical elements, but the tendency in the former case to form inter-metallic compounds or solid solutions facilitates the cohesion. The most important considerations in electro-deposition are to obtain a fast-adhering and uniform deposit. The surface conditions, properties of the base metal and deposit respectively, and the relationship between any of the respective properties are decisive factors in obtaining these qualities.

Aluminium presents special difficulties for electro-deposition by reason of its oxide film and its high position in the electro-motive scale, which latter fact tends either to produce deposition of a non-adherent metal layer at the start of plating and prevent the deposit proper from adhering or to accelerate corrosion. The difficulty of the non-adherent film can be overcome by (1) coating the metal with a fast-adhering coating of a second metal (usually Cd or Zn) to receive the coating proper; (2) working with a very big current; and (3) rendering the metal passive. The last method is most commonly used. There are also special methods which will be dealt with under the individual cases.

The oxide film is dealt with by cleansing and pickling, the necessary processes frequently being more elaborate in the case of electrolytic deposition than in the case of other methods of coating. The metal surface is first de-greased, then pickled and then burnished with powdered porcelain or pumice, being thoroughly rinsed with cold water between each process. It is subsequently coated with a thin first layer of the most suitable metal. A method has recently been introduced[14] whereby the surface of aluminium is prepared for electro-deposition by electrolytic deposit of an amalgam. A suitable bath is 10 grms. zinc chloride; 5 grms. mercuric nitrate; 200 grms. caustic soda; 200 grms. sodamide; 40 grms. stannous chloride; and 10 grms. KOH to 20 litres of water. The voltage required is 1.5; the time of the treatment a few minutes.

Metal Plating.

In metal-plating aluminium, the baths must (A) be well buffered; (B) contain a suitable addition agent (gum arabic, glucose, β-naphthol, peptone, gelatine, etc.), and (C) have a definite pH value maintained. In general, sulphate baths are preferable to cyanide baths for aluminium. Nickel, copper, cadmium and zinc are plated directly on to aluminium, and combinations of Cd-Cr, Ni-Cr, Ni-Cu-Ni, or brass, silver, gold, lead, cobalt, etc., with an intermediate plating of one of the former metals, usually Ni or Cu. Nickel is plated on a roughened surface: copper, cadmium and zinc on a smooth surface.

Nickel.—Nickel has proved, perhaps, the most satisfactory for coating aluminium. In the first place the coating adheres well, is dense, and takes a good polish: in the second place, it can be used as a preliminary for other platings which have not so far been directly producible. In the standard methods[15] of plating nickel on aluminium, the aluminium after ordinary cleansing is made passive by pickling in caustic soda and treating with cold or warm concentrated nitric acid. (It is then sometimes washed with lukewarm water and dipped in 0.2 per cent. KCN solution until it has a silvery white matt surface.) It is then again washed and placed in an etching bath. There are a variety of formulæ for the etching solution:—(1) Baths with high metal content—good for aluminium, less good for alloys; (2) baths with low metal content but high acid content—good for alloys but not for pure aluminium, and (3) acid baths without metal—good for alloys with eutectic structure. (The metals used are Fe, Mn and Ni; the acid HCl.)

After etching the ultimate nickeling is carried out in baths of any of the following compositions:—(1) $NiSO_4$ 120; $NaSO_4$ 195; NH_4Cl and boric acid, 15 grs. per litre; (2) $NiSO_4$ 140; $MgSO_4$ 75; NH_4Cl and boric acid, 15 grs. per litre; (3) Nickel ammonium sulphate 75; NaOCl 53; sod. citrate 7.5; boric acid 15 grs. per litre. (Baths (1) and (2) work with a current density of 1.5 A/dm², whilst (3) works with 0.8 A and pH = 6.) In addition to the standard methods, a number of special baths have been formulated.

A process[16] used in Germany is as follows: the aluminium is first electrolysed in a bath containing 120 gr. sodium stannate, 120 gr. tin chloride, 120 gr. zinc chloride, 120 gr. copper acetate and 30 gr. potassium hydroxide in 10 litres water (with anodes of lead) and is then nickeled in either of the baths (1) 4 kg. $NiSO_4$, 5 kg. $MgSO_4$, 300 gr. ammoniacal sodium citrate and 1 litre glycerine in 10 litres water, or (2) 5 kg. $NiSO_4$, 5 kg. $MgSO_4$, 35 gr. sodium carbonate, 20 gr. citric acid, 120 gr. glycerine in 10 litres water.

A method has recently been patented[17] which includes stoving as part of the process. The nickel after smoothing and cleansing is given potash (about 0.3 per cent.) and acid (HNO_3: H_2SO_4: water, 11.5 : 57 : 31.5) dips and is then plated in a sulphate bath of the composition $NiSO_4$, 3½ lb.; $NiCl_2$, 1 oz.; NaCl, 3 oz.; water, 1 gal. at a current density of 15 A/sq. ft. and a temperature of 20 to 25 deg. C., the pH value being about 5 to 6. The metal is then heated at 480 deg. C. for 10 to 15 min. The contact surfaces of the aluminium and nickel are supposed to form an incipient solution at this temperature and alloy together, while the outer face of the plating is completely unaffected. It is claimed that by this method a much higher polish can be obtained on the plated surface, making a subsequent plating, with chromium for example, capable of taking a high brilliance. Nickel has been plated using intermediate platings of zinc or copper, but the results are in general not very satisfactory. *Copper* is dealt with separately.

Zinc.—Zinc is more difficult to deposit on aluminium than nickel owing to its higher solution pressure, but zinc coatings afford better protection than nickel deposits under severe conditions. The aluminium does not require to be pickled; it is instead, after cleansing, exposed to a sand-blast and is well washed. The usual galvanising bath is a sulphate bath containing 145 grs. per litre $ZnSO_4$ and 35 grs. per litre sodium acetate plus 1 gr. per litre gum arabic or other addition agent. Cyanide baths containing 60 : 40 grs. per litre or 60 : 30 grs. per litre zinc cyanide or sodium cyanide and 30 or 20 c.c. per litre ammonia (0.880) can be used for preliminary plating for other metals.

Cadmium.—Cadmium plating is fairly easy, and cyanide baths give good results for this metal. The aluminium is rendered matt and passive in the usual way. A suitable bath is: Cadmium carbonate 11, potassium cyanide 35, sodium phosphate 5, potassium ferro-cyanide 7.5, gelatine 2.5 grs. per litre. The current density is 0.5 to 0.7 A/dm² and the potential 3.5 V.

Metals Plated Indirectly.

Chromium.—Of the metals plated indirectly to aluminium, chromium is of outstanding importance, and there is at present a big demand for chromed articles. Chromium can be satisfactorily plated over nickel or cadmium. The chroming bath is a sulphate solution, a typical one being: Chromium sulphate 4, chromic acid 250, sodium carbonate 14, and boric acid 3 grs. per litre. The bath is used hot (50 deg. C.) and a current density of 13 to 17 A/dm² at 4 to 5 V is used. (According to a recent patent, excellent results are obtained by chroming over a "stoved" nickel plate. See under "Nickel.")

Lead.—Lead is plated from a perchlorate solution on to a "Flash" copper plate over a primary zinc plate on the aluminium.

Other Metals.—Silver, gold and numerous other metals can be plated over nickel. Brass can also be readily applied over the nickel, but, due to the tendency for some cyanide baths to undermine the plating, particularly good nickel plating is needed.

Vulcanising.—It is now possible to fix soft rubber to aluminium by direct vulcanisation; the rubber has great resistance to corrosion and may be varied to suit the conditions, but it is, of course, injured by grease, especially mineral oils, and it will not stand a higher temperature than about 65 deg. C. nor certain oxidising agents. A trade process—"Vulcalock"—has been applied both to aluminium and Duralumin.

Colouring.—A good many processes exist for electro-treatment of aluminium to obtain a coloured surface. "Fescol" and "Alumilite" are trade processes which can be applied to give a range of colours or multi-tone effects. A good black surface is obtained by first nickeling and then electrolysing in an ammoniacal solution of ammonium molybdate (2 ozs. ammonium molybdate, ammonia (30 per cent.) 0.2 oz. per gall.), using steel anodes, and finally washing momentarily with HNO_3 or a HNO_3/H_2SO_4 mixture.[18]

Coppering.—Coppering has been given a separate heading, as it has a special application for contact purposes. For this reason the plating has to be carried out with particular care to provide a non-porous homogeneous coating, which makes thorough contact with the base metal and is sufficiently thick to be cleaned by filing or emery paper for bolted contacts. The best results are obtained for electrical work by subjecting the aluminium surface to a preliminary oxidation treatment; after the anode treatment, the metal is pickled in a hot (90 to 96 deg. C.) bath of soda 25 gr. and sodium bicarbonate 45 gr. for 10 to 20 secs. It is then quickly rinsed and coppered in a bath with copper anodes (the current being already on). The electrolyte is a 10 per cent. solution of $CuSO_4$ and the current density should be 1 A/dm². The material is left for half to 1 hour and to obtain sufficiently thick deposits is dried for 1 hour at 150 to 170 deg. C., polished, and re-inserted in the plating bath.[19]

(*Concluded on page* 331.)

14 E. de Trairup. E.P. 339,339.

15 Wogrinz-Langbeim-Pfannhauser.
16 Werner.
17 Smith and Velarde.

18 C. H. Proctor.
19 H. Ginsberg.

Trade Talk.

Employees of the Singer Manufacturing Company, Limited, Clydebank, have contributed £597 to charities during the past three months.

Messrs. Yarrow, Limited, Scotstoun, have received from the Portuguese Government orders to build four torpedo destroyers.

Messrs. J. R. Sharman and R. T. Morgan, consulting engineers, 7, Victoria Street, London, S.W.1, carrying on business as Sharman & Travers Morgan, have dissolved partnership.

Messrs. R. & W. Hawthorn, Leslie & Company, Limited, Hebburn-on-Tyne, have received from the Portuguese Government an order for the hulls and machinery of two armed sloops.

Messrs. British Reverberatory Furnaces, Limited, 88, Kingsway, London, W.C.2, have just received a repeat order from Messrs. John Holroyd & Company, Limited, Milnrow, Lancashire, for a 5-cwt. "Sklenar" furnace. This is the fifth "Sklenar" furnace Messrs. John Holroyd have installed.

As a result of the quarterly audit of the employers' books, the joint secretaries of the Board of Conciliation for the Regulation of Wages in the Pig Iron Trade of Scotland have been informed that the average net selling price was £3 14s. 2d., and that there will be a reduction of 2 per cent. in the basic rate of workmen's wages.

No agreement was reached among the workers' representatives in the engineering industry who met in London recently to decide on a reply to the employers' proposals for a revision of working conditions. It was arranged that the discussions should be adjourned until to-day, so that the executives of the forty unions represented could further consider the position.

Mining & Industrial Equipment, Limited, 11, Southampton Row, London, W.C.1, report that new orders have been received for the following equipment:—For England, an Andrews classifier and an 8-ft. Hardinge thickener, for very fine classification of special material; for France, a Ro-Tap testing sieve shaker and a Hum-mer electric screen, for screening coal at the rate of 60 tons per hour; for Australia, two Hum-mer electric screens, for screening gold ore; for Rhodesia, a Hum-mer electric screen, for screening copper ore.

The Pearson & Knowles Engineering Company, Limited, the Warrington branch of the Lancashire Steel Corporation, Limited, has secured in open competition a contract for the making and galvanising of transmission-line towers for the South-West England and South Wales electricity scheme, and for two towers to carry transmission lines across the River Thames at Dagenham. Nearly all the steel in the towers will be made by the Lancashire Steel Corporation at Irlam, near Manchester. The Dagenham towers will be each 500 ft. high.

The Pulsometer Engineering Company, Limited, of London and Reading, have recently received an order for the supply and erection of electrically-driven centrifugal-pumping plant for the Great Western Railway Company at their Barry Docks. Eight pumps are to deliver water at a pressure of 800 lbs. per sq. in. for working cranes, coal hoists, lock gates and other dock machinery. This plant will be on very similar lines to that installed by the G.W.R. at their Cardiff Docks and by the L. & N.E. Railway at their Hull Docks, both of which were supplied and erected by this company.

Edgar Allen & Company, Limited, of Imperial Steel Works, Sheffield, have appointed Mr. A. Howard Romans as technical and sales representative in the Birmingham and Midlands district, in place of Mr. Walter Scott, who has resigned. Mr. Romans, in conjunction with his colleague, Mr. J. T. Bamford, is fully competent to render useful technical service in the choice and employment of the firm's products. He has extensive experience of the Sheffield steel trade, and general engineering and technical knowledge. The address of Edgar Allen & Company's Midland office is Midland Bank Chambers, Stephenson Street, Birmingham.

The "Rangatira," a twin-screw turbo-electric-driven ship for the Union Steamship Company of New Zealand, Limited, was launched recently from the Naval Construction Works of Messrs. Vickers-Armstrongs, Limited, at Barrow-in-Furness. The "Rangatira" is intended for service between Lyttelton and Wellington, New Zealand. She has a length of 400 ft., a breadth of 58 ft., and a load draft of 17 ft. Accommodation will be provided for about 1,320 passengers and a crew of 112. The main propelling machinery consists principally of two separate turbo-alternators, each with its own condensing plant and auxiliaries, two double-unit synchronous motors which are coupled direct to the twin propeller shafts, a contactor cubicle to control the power from the alternators to the propulsion motors and two balancer booster sets for excitation purposes.

It is announced jointly by Mr. Saul G. Bron, trade representative of the U.S.S.R. in Great Britain, and Sir Philip Nash, chairman of the Metropolitan-Vickers Electrical Export Company, Limited, that a technical agreement, extending over a number of years, has just been signed between the Soviet Government and the Metropolitan-Vickers Electrical Company, Limited, under which the latter has agreed to provide expert technical assistance in the manufacture of steam turbo-generating plant, condensing plant, heavy electrical plant, industrial motors, switchgear, etc., which are to be built in Russia in the works of the All-Union Electro-Technical Combine. The plant manufactured will extend to the largest capacity required for the generation and distribution of electricity, and it will be employed in connection with the Five-Year Plan of industrial development.

Messrs. Ashmore, Benson, Pease & Company, Limited, have recently received from the Union of Soviet Socialist Republics important orders in connection with blast-furnace plant, including two pig-casting machines (double-strand type). The firm is the sole British licensee for these pig-casting machines, which they build to the design of the Pittsburgh Coal Washer Company. The production of pig-iron by these machines, which cast the hot metal into pigs of suitable size, is essential practice with modern large production blast furnaces, displacing entirely the old sand beds. They have a capacity of 120 tons of pig-iron per hr. The whole of the material for these machines will be fabricated in this country. They are to be installed on the blast-furnace plants at Kuznetsk and Magnitokorski, the erection and actual starting up of the machines being under the supervision of Messrs. Ashmore, Benson, Pease & Company, Limited. For the same clients the firm has an order for four automatic hot-blast temperature-control outfits for regulating the temperature of the hot blast to the furnaces at Kuznetsk and Magnitokorski. This equipment comprises the electrical control outfit in conjunction with the mixer and drop valves. Two of the outfits are to be installed at Kuznetsk and two at Magnitokorski, the erection and starting up of these equipments being also under the supervision of Messrs. Ashmore, Benson, Pease & Company, Limited.

Personal.

Mr. Robert Bethell has been elected President of the Staffordshire Iron and Steel Institute for the year 1931-32.

Mr. F. E. Rebbeck, of Messrs. Harland & Wolff, Limited, Belfast, is to be President of the Institute of Marine Engineers for the coming year.

Admiral D. W. Taylor, U.S.N., and Rear-Admiral Sir Douglas Brownrigg, Bt., have been elected honorary vice-presidents of the Institution of Naval Architects.

Mr. Archibald Gilchrist, chairman of Messrs. Barclay, Curle & Company, Limited, has been elected President of the Institution of Engineers and Shipbuilders in Scotland for the session 1931-32.

Mr. Peter Macgregor has resigned from the offices of chairman and managing director, and Mr. T. W. Willis has resigned from the position of works director, of Messrs. Sanderson Bros. & Newbould, Limited, Sheffield. They have retained their status as ordinary directors of the company.

Mr. F. W. Hobbs, of the Standard Brass Foundry Company, Benoni, South Africa, is, with Mrs. Hobbs, now spending a vacation in Europe. The next few weeks are to be passed at Locarno (Italy). His many friends hope that he will return to England in time to participate in the Birmingham Convention.

Wills.

Grevener, Julius, iron and steel merchant, of Queen Victoria Street, London, E.C.	£17,482
Parsons, Sir Charles Algernon, chairman of Messrs. C. A. Parsons & Company, Limited, Newcastle-upon-Tyne, and other concerns	£810,000
Laing, Andrew, a director and general manager of the Wallsend Slipway & Engineering Company, Limited, and a director of Swan, Hunter & Wigham Richardson, Limited	£298,799

Obituary.

Mr. William Matheson, shipyard manager for Messrs. R. & W. Hawthorn, Leslie & Company, Limited, Hebburn-on-Tyne, died recently.

Major Henry Meredith Leaf, D.S.O., died on Thursday, April 23, as the result of a road accident. Major Leaf, who was 68 years old, was a consulting electrical and mechanical engineer, with offices in Victoria Street, London, S.W.

The death has occurred of Mr. James McWhirter at the age of 49 years. Mr. McWhirter was for many years metallurgist with Messrs. William Beardmore & Company, Limited, Glasgow, and in the early part of this year he joined Messrs. Baldwins, Limited. He was taken suddenly ill while walking on the street and collapsed.

Mr. Joseph Pettar Bayley, general manager of Messrs. Guest, Keen & Nettlefolds, Limited, Cwmbran, died at Gibraltar on Friday, April 24. He was on his way home from a visit to India. Mr. Bayley was a native of Horsehay, Shropshire, and commenced his business career with the Horsehay Company, Limited, of which his father is a director. He went to Monmouthshire about ten years ago.

Reports and Dividends.

Robert Stephenson & Company, Limited.—Profit, £12,171; brought in, £17,769; dividend of 5 per cent.; carried forward, £19,284.

Yorkshire Copper Works, Limited.—Dividend of 10 per cent. on the ordinary shares for 1930, together with a bonus of 5 per cent., payable by the issue of a corresponding amount of 7 per cent. £1 preference shares.

The Surface Treatment of Aluminium and its Alloys.

(*Concluded from page* 330.)

For ordinary decorative purposes, or as a sub-plating for other metals, an acid sulphate bath, *e.g.*, $CuSO_4$ 100, HNO_3 60 grs. per litre, is used, the current being 1 to 1.7 A/dm² at 1 V, and the electrolysis lasting 10 to 20 min. Cyanide baths cannot be successfully used even on increasing the concentration or by adding sodium phosphate, copper lactate, etc., as different workers have proposed. The German trade name "Cupal" covers a copper-plated aluminium.

Blackening.—Any of the methods of plating to give a black surface are suitable. The "Alumilite" trade process is used considerably.

Miscellaneous.—There are a number of special electrolytic processes for producing surface coatings of various properties, the composition of the coatings frequently being very complex. One such process is the plating of aluminium in a bath of oxalic acid or oxalates. The coating obtained on the cathode is a combination of the oxalic root with the aluminium—a hard, yellowish-brown lustrous skin like adamantine spar. The metal thus coated is heat-proof and electrically insulating.[20]

Lathes are now being made with the speed control and reverse operated hydraulically instead of mechanically.

Garbage as Fuel.—The new Ford Motor Works at Dagenham are to use garbage as fuel for producing power. This should prove effective in reducing London's huge garbage piles. Three high-pressure water-tube boilers will each supply the steam requirements of a 30,000-kw. generating set. The power plant is to be designed by the Woodhall-Duckham Vertical Retort & Oven Construction Company, and will consist of 16 incineration cells, which will burn some 374 tons of London garbage every 16 hrs.

20 Kenkyu jo.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The market is quiet, and at the moment there is no sign of a change in the situation. The amount of business passing is limited, and much greater activity will be needed to keep at work even the comparatively small number of blast-furnaces now operating. Scottish business is as difficult to secure as ever it was, and the export position is bleak. Cleveland ironmasters can only compete with any success in the immediate vicinity of their own works. The majority of the limited number of orders now being placed are negotiated direct between producer and consumer, and merchants are now to a considerable extent left out of the Cleveland iron trade. Naturally, they seek to handle iron from other areas, and in several cases business has consequently been lost to this district. Ironmasters maintain their scale of fixed minimum prices, the only modification being that special delivered prices are quoted to Scottish consumers. The fixed minima are :—No. 1 Cleveland foundry iron, 61s. per ton; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s. per ton, f.o.t. or f.o.b.

A better feeling is prevalent in the East Coast hematite trade. Overseas buyers have been attracted by the recent price cuts, and the improvement in the pig-iron shipments from the Tees is due to a great extent to the heavier exports of hematite to Scandinavian and Italian ports. There is an improvement also in the home demand, and a few tentative forward inquiries are circulating. There seems to be an opportunity to reduce the somewhat heavy stocks of hematite, but the biggest holders still refuse to sell at current prices. The general market price of East Coast mixed numbers is now 65s. 6d., and for No. 1 quality 66s., but these are only quotations for small prompt lots, and better terms can be arranged for bigger quantities. Lower rates have also been accepted for export orders. Bessemer mixed numbers in the North-West of England are quoted nominally at 68s.

LANCASHIRE.—Since the beginning of this month it has been hoped that a revival of interest would be shown in the foundry iron market. So far, however, only a very moderate amount of business has been done. For delivery to consumers in the Manchester price zone, prices of Derbyshire and Staffordshire descriptions remain at 69s. 6d. per ton, with North-East Coast iron at 69s. 6d., Northamptonshire foundry 68s., Derbyshire forge 64s. 6d., Scottish foundry brands 88s. 6d., and West Coast hematite iron at about 82s. 6d.

MIDLANDS.—Ironfounders, whether dealing with light or heavy castings, are very poorly engaged, and there seems little likelihood of an appreciable expansion of demand in the immediate future. For delivery to Birmingham and Black Country stations the furnaces quote 67s. 6d. for Northants No. 3 and 71s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—There is a general lack of business in Scotland. The shipbuilders are badly in need of more trade, and in these circumstances the engineering founders especially can hardly expect any improvement in their present position. Scottish foundry iron is quoted at 73s. 6d. per ton, f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1. The price of Continental No. 3 is 52s. 6d. to 54s., f.o.t. Grangemouth, and Middlesbrough No. 3 is at 60s.

Finished Iron.

The finished-iron market is uneventful. Little business is being done in any direction, but the scarcity of trade is particularly noticeable in the case of crown and the cheaper grades of iron. The makers of marked bars, who recently reduced their price to £12, are poorly situated, although they are better occupied than the makers of the cheaper grades of iron. Staffordshire crown iron is offered at £9 5s. to £10, according to specification, while nut and bolt iron is at between £8 12s. 6d. and £8 15s. The makers of bolt iron are poorly supported, and can scarcely be otherwise, while foreign material remains available at the present low levels. The Belgian No. 3 product for nut and bolt and fencing work is quoted at between £4 15s. and £4 17s. 6d., delivered to consumers' works in the Black Country.

Steel.

There is only a very limited demand for finished steel. Business in all areas is restricted, and there is nothing encouraging in the forward outlook. Home buyers are placing few orders, and, while rather more inquiries are circulating in one or two overseas markets, the general export demand is still very poor. The Continental market for semi-finished steel is again weaker, prices showing a further decline on the week. This decline in prices has taken place in the face of strenuous efforts to maintain quotations, and in spite of the fact that some of the mills are still off the market. In the face of the keen competition from the Continent, the volume of business being placed with the British works is very small, and tends to decline still further.

Scrap.

The Cleveland iron and steel scrap market is still very dull. The supply of all classes of scrap still exceeds the demand, and transactions are limited to small quantities. Prices are inclined to sag. Ordinary-quality cast-iron scrap is at 47s., with good machinery quality at 48s. 6d. A further weakening in prices seems probable in the Midlands. In many cases works have suspended deliveries against existing contracts, and no new business has transpired. Good heavy machinery cast-iron scrap in cupola sizes is offered at 50s. to 52s. 6d., and light cast iron is at 37s. 6d. No improvement is reported in the position of the Scottish market. It is difficult to find an outlet for any class of scrap. Owing to the uncertain working at both rolling mills and melting furnaces consumers are unable to reduce the stocks they hold. Any movement of prices continues to have a downward tendency. The price of first-class machinery metal, in pieces not exceeding 1 cwt., is still 50s., while ordinary cast-iron scrap to the same specification is at 46s. 3d. to 47s. 6d. The above prices are all delivered consumers' works.

Metals.

All metals are severely depressed, prices relapsing alarmingly, although in the last few days there has been some recovery from the lowest levels. On Monday standard copper dropped £1 per ton to £39 17s. 6d. for cash, which is the lowest figure touched for thirty-six years. Tin prices also fell to very low levels, comparing with £100 for cash tin touched in the year 1902. In the case of pig-lead and zinc new low records were reached on Monday, when the former was at £11 8s. 9d. and the latter £10 8s. 9d. With the possible exception of copper, the consumption of non-ferrous metals is receding still further, and, with markets severely effected by unwieldy stocks, the prospects are unusually poor.

Copper.—Little business is being done. Moderate quantities have been bought at the reduced price, but there seems little likelihood of an immediate improvement in conditions. News from America is the reverse of encouraging. All expectations of an early recovery in the industrial situation seem to have vanished, and the outlook is most uncertain. The Customs' smelters have been selling copper at 9¼ cents per lb., and there have been dealings in second-hand metal at below 9 cents per lb.

Closing quotations :—

Cash.—Thursday, £41 3s. 9d. to £41 5s.; Friday, £40 17s. 6d. to £41; Monday, £39 17s. 6d. to £40; Tuesday, £40 to £40 2s. 6d.; Wednesday, £40 6s. 3d. to £40 8s. 9d.

Three Months.—Thursday, £41 16s. 3d. to £41 17s. 6d.; Friday, £41 10s. to £41 11s. 3d.; Monday, £40 10s. to £40 11s. 3d.; Tuesday, £40 13s. 9d. to £40 15s.; Wednesday, £40 18s. 9d. to £41 1s. 3d.

Tin.—The tin statistics for April reveal another increase of 472 tons in the visible supply, in addition to which there has been an increase in the unshipped surplus in Malaya of 2,641 tons. The visible supply amounts to 48,136 tons, as against 36,024 tons last year. April supplies were 10,288 tons, including Straits shipments of 7,843 tons. The total deliveries amounted to 9,916 tons, including the American figures of 6,630 tons, while outgoings in the U.K. and on the Continent were poor.

Official closing prices :—

Cash.—Thursday, £104 10s. to £104 12s. 6d.; Friday, £105 10s. to £105 12s. 6d.; Monday, £102 17s. 6d. to £103; Tuesday, £103 15s. to £104; Wednesday, £105 10s. to £105 12s. 6d.

Three Months.—Thursday, £105 17s. 6d. to £106; Friday, £106 15s. to £106 17s. 6d.; Monday, £104 5s. to £104 7s. 6d.; Tuesday, £105 2s. 6d. to £105 5s.; Wednesday, £106 15s. to £106 17s. 6d.

Spelter.—The demand for prompt material is limited, so that the further substantial arrivals of spelter which are expected will no doubt find their way into warehouse. The consumption generally has been small, due to the poor state of consumers' order books.

Daily fluctuations :—

Ordinary. — Thursday, £10 10s.; Friday, £10 12s. 6d.; Monday, £10 8s. 9d.; Tuesday, £10 10s.; Wednesday, £10 13s. 9d.

Lead.—The requirements of the cable industry during the last few months have shown a considerable decline. Present conditions are bad, and there is no consolation to be gained from the outlook.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £11 12s. 6d.; Friday, £11 12s. 6d.; Monday, £11 8s. 9d.; Tuesday, £11 13s. 9d.; Wednesday, £11 17s. 6d.

Iron Pots for Melting Aluminium.—Where iron pots are used for melting aluminium the iron may be corroded, due to the corrosive action of aluminium. The iron for the pots should be carefully selected, grey iron being most suitable. A suitable pot wash may be made from a mixture of graphite and lime made into a thin paste with water. If this is applied to the inside of the pots the iron will to a great extent be protected from the corrosive effects of the molten aluminium.

CAST IRON FLANGED PIPES
2 in.—12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone : 3852 (2 Lines). MIDDLESBROUGH. Telegrams : "Ritchie, Middlesbrough."

F.T.J. 7/5/31.

Aluminium alloy castings for Wellington, New Zealand, tramcars.
(By courtesy of W. A. J. Dutch.)

Castings for Rolling Stock

Rolling stock and road vehicle designers lighten construction with aluminium and aluminium light alloys for the sake of more room, more speed, improved stability and simplified braking. To the founder, the diversity of light aluminium alloys now available offers a rapidly developing field in this section of industry. Aluminium-copper and aluminium-copper-zinc for the simplest castings. Aluminium-silicon for parts requiring thin sectioning or special corrosion-resistance. Y-alloy, heat-treated, for pistons and other parts which must retain strength at comparatively high temperatures. And a host of specially mixed alloys for miscellaneous uses. Write for Foundry Booklet—328.

Light Alloys of Aluminium

THE BRITISH ALUMINIUM CO. LTD.

ALUMINIUM PRODUCERS, ADELAIDE HOUSE, LONDON, E.C.4

Phone: Mansion House 5561 & 8074. 'Grams: Cryolite, Bilgate, London.

Special CARBON BLACKING

67 YEARS EXPERIENCE. MADE BY A FIRM WITH

PLUMBAGO

CORE GUM

WHITE DUST

COAL DUST

REQUISITES

Also—

GANISTER, LOAM AND SAND MILLS.

STUDS, CHAPLETS, BRUSHES, CORE ROPES, BUCKETS, SPADES, Etc. LADLES, FIRE BRICKS, STONE FLUX, CASTING CLEANERS, PIPE NAILS, SPRIGS, WIRE BRUSHES, BELLOWS,

JAS. DURRANS & SONS, LIMITED.

PHŒNIX WORKS, PENISTONE, NR. SHEFFIELD.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	40	6	3
Three months	40	18	9
Electrolytic	43	0	0
Tough	41	10	0
Best selected	42	0	0
Sheets	75	0	0
India	53	10	0
Wire bars	45	5	0
Do., June	45	5	0
Do., July	45	5	0
Ingot bars	45	5	0
H.C. wire rods	46	0	0
Off. av. cash, April	42	14	8¼
Do., 3 mths., April	43	7	10½
Do., Sttlmnt., April	42	14	9
Do., Electro, April	45	17	0
Do., B.S., April	44	12	6
Do., wire bars, April	46	6	0
Solid drawn tubes			10¼d.
Brazed tubes			10¾d.
Wire			6¾d.

BRASS.

Solid drawn tubes	9¼d.
Brazed tubes	11¼d.
Rods, drawn	9d.
Rods, extd. or rlld.	5¼d.
Sheets to 10 w.g.	8¾d.
Wire	8d.
Rolled metal	7¾d.
Yellow metal rods	5¼d.
Do. 4 × 4 Squares	6d.
Do. 4 × 3 Sheets	6¼d.

TIN.

	£	s.	d.
Standard cash	105	10	0
Three months	106	15	0
English	106	10	0
Bars	108	10	0
Straits	107	10	0
Australian	106	10	0
Eastern	107	0	0
Banca	108	10	0
Off. av. cash, April	112	16	9
Do., 3 mths., April	114	4	9
Do., Sttlmt., April	112	16	9

SPELTER.

	£	s.	d.
Ordinary	10	13	9
Remelted	9	12	6
Hard	8	7	6
Electro 99.9	12	15	0
English	10	17	6
India	9	12	6
Zinc dust	19	0	0
Zinc ashes	2	10	0
Off. aver., April	11	11	10¾
Aver. spot, April	11	7	0¾

LEAD.

	£	s.	d.
Soft foreign ppt.	11	17	6
English	13	5	0
Off. average, April	12	9	9¾
Average spot, April	12	7	6

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	20	0	0
Do., V.M. ex-whf.	19	0	0
Rods	22	12	6
Boiler plates	13	10	0
Battery plates	15	0	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	36	0	0
Chinese	23	15	0
Crude	22	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	21	8	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 12 6
45/50%	£11 0 0
75%	£17 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£15 10 0
Ferro-tungsten—	
80/85%	1/8½ lb.
Tungsten metal powder—	
98/99%	1/11½ lb.
Ferro-chrome—	
2/4% car.	£28 0 0
4/6% car.	£20 10 0
6/8% car.	£19 10 0
8/10% car.	£19 0 0
Ferro-chrome—	
Max. 2% car.	£29 10 0
Max. 1% car.	£33 10 0
Max. 0·70% car.	£36 1 0 0
70% carbon-free	9½d. lb.
Nickel—99% £170 0 0 to £175 0 0	
Ferro-cobalt	9/– lb.
Aluminium 98/99%	£85 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£11 5 0
76/80% packed	£12 5 0
76/80% export	£ 9 0 0
Metallic manganese—	
94/96% carbonless	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales							
Heavy steel	2	6	0	to	2	7	0
Bundled steel and shrngs.	1	18	6	to	2	3	0
Mixed iron and steel	1	17	6	to	2	0	0
Heavy cast iron					2	8	0
Good machinery for foundries					2	12	6
Cleveland—							
Heavy steel					2	2	6
Steel turnings					1	8	6
Cast-iron borings					1	3	6
Heavy forge					2	14	6
W.I. piling scrap					2	10	0
Cast-iron scrap	2	7	0	to	2	8	6
Midlands—							
Light cast-iron scrap					1	17	6
Heavy wrought					2	12	6
Steel turnings						—	
Scotland—							
Heavy steel					2	2	6
Ordinary cast iron					2	6	6
Engineers' turnings					1	11	6
Cast-iron borings					1	13	0
Wrought-iron piling					2	13	6
Heavy machinery					2	10	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	31	0	0
Brass	22	0	0
Lead (less usual draft)	9	5	0
Tea lead	6	5	0
Zinc	4	15	0
New aluminium cuttings	46	0	0
Braziery copper	31	0	0
Gunmetal	30	0	0
Hollow pewter	70	0	0
Shaped black pewter	45	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/–
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/–
Hematite No. 1	66/–
Hematite M/Nos.	65/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	74/–
,, d/d Birm.	86/6
Malleable iron d/d Birm.	117/6
Midlands—	
Staffs common*	—
,, No. 4 forge*	66/–
,, No. 3 fdry.*	71/–
Shrops basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	62/6
,, fdry. No. 3*	67/6
,, fdry. No. 1*	70/6
Derbyshire forge*	66/–
,, fdry. No. 3*	71/–
,, fdry. No. 1*	74/–
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	76/–
,, No. 3	73/6
Hem. M/Nos. d/d	72/–
Sheffield (d/d district)—	
Derby forge	61/–
,, fdry. No. 3	66/–
Lincs forge	—
,, fdry. No. 3	66/–
E.C. hematite	81/6
W.C. hematite	84/6
Lancashire (d/d eq. Man.)—	
Derby forge	64/6
,, fdry. No. 3	69/6
Staffs fdry. No. 3	69/6
Northants fdry. No. 3	68/–
Cleveland fdry. No. 3	69/6
Dalzell, No. 3 (special)	105/ 107/6
Summerlee, No. 3	88/6
Glengarnock, No. 3	—
Eglinton, No. 3	88/6
Gartsherrie, No. 3	88/6
Monkland, No. 3	88/6
Shotts, No. 3	88/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	10	0	0	to	10	10	0
Nut and bolt iron	8	12	6	to	8	15	0
Hoops	10	10	0	to	12	0	0
Marked bars (Staffs) f.o.t.					12	0	0
Gas strip	10	10	0	to	12	0	0
Bolts and nuts, ¾ in. × 4 in.					14	5	0
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	9	0	0	to	9	15	0
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ¾ in. (Untested)	7	2	6	to	7	10	0
Flats—8 in. wide and over					8	12	6
,, under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates					12	0	0
Hoops (Staffs)	9	5	0	to	9	10	0
Black sheets, 24g.	8	10	0	to	9	10	0
Galv. cor. shts. 24g.					11	0	0
Galv. flat sheets					11	10	0
Galv. fencing wire, 8g. plain					12	0	0
Billets, soft	5	2	6	to	5	12	6
Billets, hard	7	2	6	& up.			
Sheet bars	5	0	0	to	5	7	6
Tin bars	5	0	0	to	5	7	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	11½d.
Sheet to 10 w.g.	11¾d.
Wire	1/0½
Rods	11¾d.
Tubes	1/6½
Castings	11¾d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/– to 10 g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	17.76
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	12.00
Basic	18.26
Bessemer	18.76
Malleable	18.76
Grey forge	17.26
Ferro-mang. 80%	80.00
O.-h. rails, h'y, at mill	43.00
Billets	30.00
Sheet bars	30.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.65
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.65
Skelp, sheared steel	1.65
Steel hoops	1.85
Sheets, black, No. 24	2.35
Sheets, galv., No. 24	2.85
Sheets, blue an'l'd, No. 13	2.00
Wire nails	1.90
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	22/6 to 25/-
,, furnace	15/-
Durham and Northumberland—	
,, foundry	13/6 to 14/-
,, furnace	13/6
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box		15/-
,,	28×20 ,,		30/-
,,	20×10 ,,		21/10½
,,	18¾×14 ,,		15/10½
C.W.	20×14 ,,		14/3
,,	28×20 ,,		28/3
,,	20×10 ,,		21/-
,,	18¾×14 ,,		14/9
Terneplates	28×20		31/- per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	17	6	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods dead soft, st'l	£11	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ⅛ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	62½%	47½%
Water ..	58½%	42½%
Steam ..	55%	37½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Apr.	30 ..	41	3	9	dec.	10/-
May	1 ..	40	17	6	,,	6/3
,,	4 ..	39	17	6	,,	20/-
,,	5 ..	40	0	0	inc.	2/6
,,	6 ..	40	6	3	,,	6/3

Electrolytic Copper.

		£	s.	d.		
Apr.	30 ..	44	0	0	dec.	5/-
May	1 ..	44	5	0	inc.	5/-
,,	4 ..	43	10	0	dec.	15/-
,,	5 ..	43	0	0	,,	10/-
,,	6 ..	43	0	0	No change	

Standard Tin (cash).

		£	s.	d.		
Apr.	30 ..	104	10	0	dec.	67/6
May	1 ..	105	10	0	inc.	20/-
,,	4 ..	102	17	6	dec.	52/6
,,	5 ..	103	15	0	inc.	17/6
,,	6 ..	105	10	0	,,	35/-

Tin (English ingots).

		£	s.	d.		
Apr.	30 ..	105	10	0	dec.	70/-
May	1 ..	106	10	0	inc.	20/-
,,	4 ..	104	0	0	dec.	50/-
,,	5 ..	105	0	0	inc.	20/-
,,	6 ..	106	10	0	,,	30/-

Zinc Sheets (English).

		£	s.	d.		
Apr.	30 ..	20	0	0	No	change
May	1 ..	20	0	0	,,	,,
,,	4 ..	20	0	0	,,	,,
,,	5 ..	20	0	0	,,	,,
,,	6 ..	20	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
Apr.	30 ..	10	10	0	dec.	2/6
May	1 ..	10	12	6	inc.	2/6
,,	4 ..	10	8	9	dec.	3/9
,,	5 ..	10	10	0	inc.	1/3
,,	6 ..	10	13	9	,,	3/9

Lead (English).

		£	s.	d.		
Apr.	30 ..	13	0	0	dec.	5/-
May	1 ..	13	0	0	No change	
,,	4 ..	13	0	0	,,	
,,	5 ..	13	0	0	,,	
,,	6 ..	13	5	0	inc.	5/-

AVERAGE MONTHLY PRICES OF FURNACE COKE D/D MIDDLESBROUGH.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1901	0 17 6	0 14 0	0 13 0	0 14 0	0 14 6	0 15 0	0 15 3	0 15 3	0 15 9	0 16 6	0 16 9	0 16 9	0 16 4½
1902	0 16 9	0 15 0	0 15 0	0 15 0	0 15 0	0 15 3	0 15 3	0 15 3	0 15 6	0 16 0	0 16 6	0 16 0	0 15 5
1903	0 15 9	0 16 0	0 16 3	0 16 9	0 16 6	0 16 3	0 16 0	0 15 9	0 15 6	0 15 0	0 14 6	0 14 0	0 15 8½
1904	0 13 9	0 13 9	0 13 3	0 14 3	0 14 6	0 14 3	0 14 3	0 14 3	0 14 3	0 14 0	0 14 0	0 14 6	0 14 1½
1905	0 14 9	0 15 3	0 15 3	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 9	0 17 0	0 15 5½
1906	0 17 6	0 17 6	0 17 0	0 17 0	0 17 0	0 16 6	0 17 0	0 17 0	0 18 3	0 18 6	0 19 0	1 0 0	0 17 8½
1907	1 4 6	1 5 0	1 5 0	1 0 6	1 2 0	1 1 0	1 1 0	1 1 0	1 2 0	1 1 6	1 0 0	0 17 0	1 1 8½
1908	0 16 0	0 16 0	0 15 6	0 16 0	0 16 3	0 16 0	0 15 6	0 15 6	0 15 6	0 15 3	0 16 0	0 16 0	0 15 9½
1909	0 16 0	0 15 3	0 15 0	0 14 9	0 15 6	0 15 9	0 15 6	0 15 6	0 16 6	0 17 0	0 17 6	0 17 0	0 15 11½
1910	0 18 4½	0 18 6½	0 18 0	0 18 0	0 17 10½	0 17 0	0 16 1½	0 15 9½	0 15 11	0 16 0	0 15 9½	0 15 8	0 16 11
1911	0 16 0	0 15 10½	0 15 6	0 15 3	0 14 9	0 14 6	0 14 6	0 14 6	0 14 6	0 14 11½	0 15 0½	0 16 3½	0 15 1½
1912	0 17 3	0 17 3	0 18 6	0 18 10	0 19 0	0 19 4½	0 19 10½	1 0 9½	1 2 9	1 4 1½	1 5 8½	1 8 6	1 1 0
1913	1 5 9	1 4 11	1 5 0	1 5 0	1 4 9½	1 0 4½	0 19 5½	0 18 3	0 18 0	0 18 2½	0 18 6	0 18 6	1 1 4½
1914	0 18 2	0 17 1	0 17 0	0 17 0	0 17 4	0 17 6	0 17 6	0 18 5	0 18 4	0 17 9	0 17 6	0 18 5	0 17 8
1915	0 17 10½	0 17 9	1 0 4½	1 7 7½	1 9 4½	1 10 7½	1 9 7	1 7 3	1 5 4	1 4 9	1 9 6	1 13 0	1 6 1
1916	1 10 9	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6½
1917	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 14 3	1 15 6	1 11 2½
1918	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6
1919	1 15 6	1 15 6	1 15 6	1 15 6	2 1 6	2 1 6	2 3 9	2 10 6	2 10 6	2 10 6	2 10 6	2 10 6	2 3 5
1920	2 12 3	2 14 0	2 19 0	2 19 0	3 3 8	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 2 6
1921	3 1 0½	2 19 0	2 16 0	2 7 0	2 6 6	2 6 6	2 0 6	2 0 0	1 13 11	1 12 9	1 10 4½	1 8 3	2 3 6½
1922	1 7 0½	1 8 1½	1 9 7½	1 8 4½	1 7 11½	1 7 3	1 6 9½	1 6 10½	1 7 0½	1 10 2½	1 10 0	1 9 11½	1 8 3½
1923	1 11 3	1 14 6	2 0 1½	2 2 8½	2 4 4½	2 2 10½	2 1 0½	2 1 6	2 0 9½	1 18 9	1 18 8½	1 18 3	1 19 7½
1924	1 16 6½	1 14 9	1 11 11½	1 10 0½	1 8 1½	1 7 8½	1 7 3	1 6 3	1 6 0	1 5 0	1 5 0	1 5 0	1 9 5½
1925	1 4 10½	1 4 1½	1 13 3	1 2 4½	1 2 2½	1 1 5½	1 1 3½	1 4 9	0 18 10½	0 18 4½	0 19 6½	1 1 4½	1 2 8½ (5 months)
1926	1 2 1½	1 0 9	0 19 2½	0 18 6½	Strike	Strike	Strike	Strike	Strike	Strike	Strike	1 5 0	1 1 1½
1927	1 5 6	1 4 9½	1 6 1½	1 3 9	1 2 6	1 0 8½	0 19 4½	0 19 0	0 18 7½	0 18 0	0 17 10½	0 17 6	1 1 1½
1928	0 17 6	0 17 10½	0 18 0½	0 17 11½	0 17 8½	0 17 6½	0 17 7½	0 17 6½	0 17 6	0 17 7½	0 17 7½	0 17 6	0 17 8
1929	0 17 7½	0 18 0	0 19 0	0 19 6½	0 18 10½	0 19 10½	1 1 3½	1 1 8½	1 3 0	1 3 6	1 3 8	1 3 1½	1 0 9½
1930	1 2 6½	1 1 3	1 0 3	0 19 1½	0 17 7	0 16 10½	0 16 6	0 16 6	0 16 9	0 17 0	0 17 0	0 17 0	0 18 2½
1931	0 17 0	0 16 7½	0 16 0	0 16 0	—	—	—	—	—	—	—	—	—

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